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EVALUATION OF ANTIFUNGAL EFFECTS OF PLANT LEAVES EXTRACTS ON ISOLATED *RHIZOPUS SPECIES* FROM SOIL

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Keywords:

Mucormycetes, *Carica papaya*, *Citrus limon*, *Psidium guajava*, *Acalypha indica* and *Rhizopus species*, disc diffusion

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ABSTRACT: Mucormycetes are a group of fungi causing a serious infection called mucormycosis. These fungi live throughout the environment, particularly in soil than in the air. This fungus is severely spread among people who have weakened immune systems; breathing in these spores can cause severe infection in the lungs or sinuses, which can spread easily to other parts of the body. In the present work, *Rhizopus species* was isolated from soil and antifungal activity of different solvent extracts of young leaves of *Carica papaya* (Papaya), *Citrus limon* (lemon), *Psidium guajava* (guava) and *Acalypha indica* (Indian nettle) were tested against *Rhizopus species* using the disc diffusion method. It was observed that all four plant leaves exhibit positive activity against *Rhizopus species.* Ethanolic extract of *Carica papaya* leaves (75mg/ml) showed more potency with an inhibition zone of 20 ± 0.2 mm. Aqueous extracts (25mg/ml) of *Acalypha indica* leaves (7±0.2 mm) showed lowest zone of inhibition found in against *Rhizopus species*. Antifungal activity of aqueous, ethanol, and chloroform extracts of *Citrus limon* leaves and *Psidium guajava* leaves also were determined. The results showed that more potential antifungal activity is exhibited with ethanol extract of *Carica papaya* leaves (75mg/ml). The present study confirmed the presence of antifungal compounds in shade-dried ethanol extracts of *Carica papaya* leaves against isolated *Rhizopus species* from the soil.

INTRODUCTION: The amount and type of microorganisms in a particular section of soil are associated with several factors, such as sunlight, temperature, moisture, soil pH, nutrients, and reduction potential [1]. Various types of microorganisms are present in the soil. Among them, numerous groups of fungi are widely distributed in soil, and they play important roles in the soil environment some groups of fungi act as soil-borne pathogens.

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Today, it is well established that soil can be a reservoir of most pathogenic and opportunistic fungi [2-5]. Soil-borne pathogenic fungi directly enter the human body through direct inoculation into wounds or contaminated food by direct or indirect soil ingestion. Fungal spores may be dispersed in different environments via mud or dust particles from soil and enter the respiratory tract [1, 5].

Mostly, mucorales is an order of saprophytic fungi growing on organic substances, such as dead plants, animal waste materials in soil, or food [6, 7]. In the soil, these mucorales may survive for a long time before infecting humans who are in contact with contaminated soil [8]. In 2007, in a taxonomic reclassification, Zygomycetes were abolished as a class and zygomycosis is now mainly attributed to the order Mucorales of subphylum Mucoromycotina [9]. Therefore, previously known zygomycosis is now termed as "Mucormycosis". This termis now used in opportunistic infections caused by the order Mucorales [10]. Following aspergillosis and candidiasis, mucormycosisis are the third most common invasive fungal infection [11]. The importance of mucormycosis has been highlighted in recent years as a consequence of the dramatic increase in the number of patients with predisposing factors [12-14]. In many cases, the most common genus causing human Mucormycetes infection is *Rhizopus* followed by *Mucor* and *Lichtheimia* mucormycosis was found in 70 to 80% of all mucormycosis [15, 16].

Plants are a primary source of new natural medicinal products [17]. Of 119 drugs still extracted from plants and used globally, 74% were discovered during an attempt to identify the chemical substances amongst medicinal plants responsible for combating human diseases [18]. More importantly, some of the plant's natural products have various biological activities such as anti-inflammatory, anticarcinogenic and anti-atherosclerotic, antibacterial, antifungal, antiviral, antimutagenic and antiallergic activities [19, 20]. These biological activities may be associated with their antioxidant activity [21]. The antimicrobial activities of plant extracts have formed the basis of many applications, including raw and processed food preservation, pharmaceuticals, alternative medicine, and natural therapies [22, 23]. From the above literature survey, research was carried out to investigate the use of some plant leaves extracts for the control mucormycetes species. This research was aimed to test the efficacy of the crude extracts of Young leaves of *Carica papaya* (papaya), *Citrus limon* (lemon), *Psidium guajava* (guava) and *Acalypha indica* (Indian nettle) for the control of mucormycetesas well as to determine the best plant extracts that are comparable to the efficacy of fungicide so that it can be used as an alternative to the fungicide.

MATERIALS AND METHODS:

Sample Collection: In December 2021, twenty soil samples were collected from twenty different cultivated lands in and around Periyakulam, Theni District. All the dust and debris were first removed from the soil surface. Then, approximately 400 gm of soil at a depth of 5-10 cm was collected from the surface layer and stored in sterile bags using a sterile stainless steel spoon [24]. All the soil samples were transferred immediately to a microbiology laboratory for the next processing stage.

Isolation of Mucormycetes Species: The soil samples were crushed in a mortar and then homogenized in sterile conditions. Afterward, 5 gm of each soil sample was suspended in 20 ml of sterile double-distilled water and shaken for 5 min to prepare a soil suspension [25, 26]. Sterilized and cooled agar medium of Sabouraud Dextrose Agar (SDA) supplemented with chloramphenicol (50mg/l), was added to the sterile Petri plates. 0.5 ml of the suspension was poured approximately into the bottom of a Petri dish and spread using a sterile L Rod. All the plates were incubated at 27°C for 2-4 days, and fungal colony growth was observed daily. The primary identification of mucormycetes species was performed based on macroscopic by colony morphology and microscopic by lactophenol cotton blue mount [27].

Microscopic Examination: A 1 cm square of adhesive tape was cut, and with the help of sterile forceps, it was placed on the surface of mycelia and lifted off slowly. A few drops of lactophenol cotton blue (LPCB) were placed on another slide. An adhesive tape containing the fungal mycelia was placed on lactophenol cotton blue and then mounted was observed under low power 10X and high power 45X objective lens of the light microscope [28, 29].

Preparation of Fungal Inoculum: Fungal culture was scraped with a sterile loop to prepare inoculum suspension for mucormycetes species. Spores were collected in Sabouraud Dextrose broth. The fungal suspension was passed through sterile cheesecloth to clear residual hyphae. The inoculum was adjusted to 1 to 5×10^6spores/ml by adjusting the optical density at 625 nm to 0.08 and 0.1 [30].

Collection and Identification of Plant Materials: 10 Young leaves of *Carica papaya* (papaya), *Citrus limon* (lemon), *Psidium guajava* (guava), and *Acalypha indica* (Indian nettle) were collected from ARK Organic farm, Periyakulam Taluk, Theni district, Tamilnadu, India. The plant samples were authenticated by Dr. P. Prabakaran, Assistant

Professor, Department of Botany, M. R. Government Arts College, Mannargudi. With running tap water, the plant materials were washed to remove soil and dust materials on plant leaves and washed with distilled water to remove any contamination. After that, plant materials are washed with 95% ethanol to make them sterile. All the plant leaves were dried in the shade to evaporate all the water molecules, and after that, dried plant leaves were grinding. With the help of mortar and pestle, leaves of *Carica papaya* (Papaya), *Citrus limon* (Lemon), *Psidium guajava* (Guava) and *Acalypha indica* (Indian nettle) ground well into fine powder form and stored in polythene bags with proper labeling [31].

Preparation of Plant Leaves Extracts: For the preparation of aqueous, ethanol, and chloroform extract, One gram (1gm) of dried powder of experimental material of all plants leaves were soaked in 20 ml of water, ethanol, and chloroform respectively for24hrs and kept in a shaking incubator at 50-60 rpm & 40ºC.

The mixture was then filtered through the Whatman No.1 filter paper to ensure that no particles were present in the solution, and the extract was collected and evaporated to dryness with a rotary evaporator. For antifungal activity assays, a stock solution was made for each extract with 50 mg/ml in dimethyl sulfoxide (DMSO) and mixed well by vortexing. The stock was stored at 40°C, until used [32].

Antifungal Activity of Plant Extract on Isolated Mucormycetes:

Antifungal Assay: Antifungal activity tests against isolated mucormycetes were performed by using the disk diffusion method [33]. Test plates were prepared with 20 ml of sterile Sabouraud Dextrose Agar. The standardized isolated fungal inoculum was applied to the solidified culture medium by using sterile cotton swabs and allowed to dry for 5 min. A sterile paper disk (6mm) was impregnated with different concentrations (25, 50, and 75 mg/ml) of each plant leaves extract. The disks were aseptically transferred on the inoculated agar plates and incubated for 2 to 4 days. Antifungal activity was determined by measuring clear zones around discs. The clear zones indicated that the fungicidal effect of plant leaf extracts isolated mucormycetes species [34]. Terbinafine (250µg) disks were used as a standard reference or positive controls, and disks impregnated with 1% DMSO were used as negative controls. All tests were performed in triplicate.

RESULTS:

Macroscopic and Microscopic Identifications: Typically, floccose and dense colonies were observed on seven Petri plates. These colonies rapidly filled the entire Petri plates with existing large intertwined aerial mycelium, resembling grey cotton candy.

The colonies were subjected to lactophenol cotton blue mount staining. Microscopic appearances are oval shape spores, non-septate mycelium, and straight sporangiophores that terminate with black sporangium containing a columella and root-like hyphae. Isolated colonies were identified as Rhizopus species from the macroscopic and microscopic characteristics.

Antifungal Activities of Leaves Extracts: Extracts from plant leaves were investigated for their antifungal effect against isolated *Rhizopus species*. Among the plant leaves extracts the best activity found in the investigation was observed with the ethanol extract (75mg/ml) of *Carica papaya* leaves (20 ±0.2mm), which inhibited the growth of isolated *Rhizopus species.* The lowest zone of inhibition was found in aqueous extracts (25mg/ml) of *Acalypha indica*leaves (7±0.2mm) against *Rhizopus species*. The results were tabulated in **Table 1, 2,** and **3** and **Fig. 1, 2,** and **3.**

TABLE 1: ANTIFUNGAL ACTIVITY OF AQUEOUS EXTRACTS OF PLANT LEAVES ON ISOLATED RHIZOPUS SPECIES

S. no.	Plant leaves extract	Zone of inhibition (nm)				
		Aqueous			Positive control	Negative control
		25mg	50mg	75mg		
1	*Carica papaya*	10± 0.2	12± 0.1	15± 0.2	28±0.1	Not detected
2	*Citrus limon*	8 ±0.1	15±0.1	12± 0.2		
3	*Psidium guajava*	11 ±0.2	12±0.2	14± 0.1		
4	*Acalypha indica*	7± 0.2	9± 0.1	11 ±0.2		

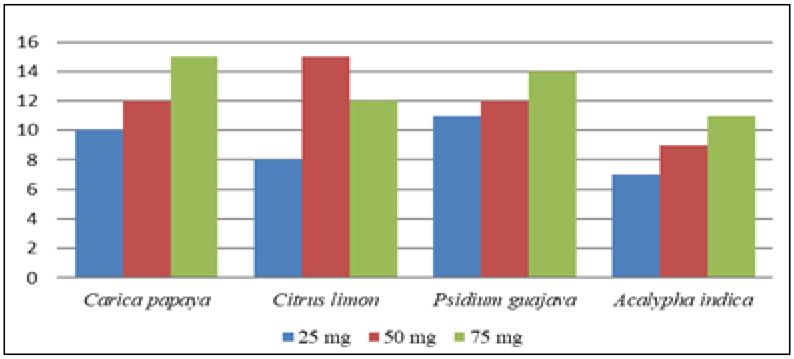

FIG. 1: ANTIFUNGAL ACTIVITY OF AQUEOUS EXTRACTS OF PLANT LEAVES ON ISOLATED *RHIZOPUS SPECIES*

TABLE 2: ANTIFUNGAL ACTIVITY OF ETHANOL EXTRACTS OF PLANT LEAVES ON ISOLATED *RHIZOPUS SPECIES*

S. no.	Plant leaves extract	Zone of inhibition (nm)				
		Ethanol			Positive control	Negative control
		25mg	50mg	75mg		
1	*Carica papaya*	10± 0.2	12± 0.1	15± 0.2	28±0.1	Not detected
2	*Citrus limon*	8 ±0.1	15±0.1	12± 0.2		
3	*Psidium guajava*	11 ±0.2	12±0.2	14± 0.1		
4	*Acalypha indica*	7± 0.2	9± 0.1	11 ±0.2		

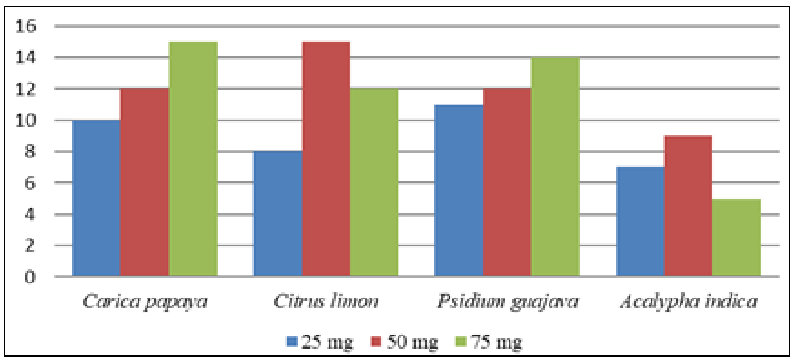

FIG. 2: ANTIFUNGAL ACTIVITY OF ETHANOL EXTRACTS OF PLANT LEAVES ON ISOLATED *RHIZOPUS SPECIES*

TABLE 3: ANTIFUNGAL ACTIVITY OF CHLOROFORM EXTRACTS OF PLANT LEAVES ON ISOLATED *RHIZOPUS SPECIES*

S. no.	Plant leaves extract	Zone of inhibition (nm)				
		Chloroform			Positive control	Negative control
		25mg	50mg	75mg		
1	*Carica papaya*	10± 0.2	12± 0.1	15± 0.2	28±0.1	Not detected
2	*Citrus limon*	8 ±0.1	15±0.1	12± 0.2		
3	*Psidium guajava*	11 ±0.2	12±0.2	14± 0.1		
4	*Acalypha indica*	7± 0.2	9± 0.1	11 ±0.2		

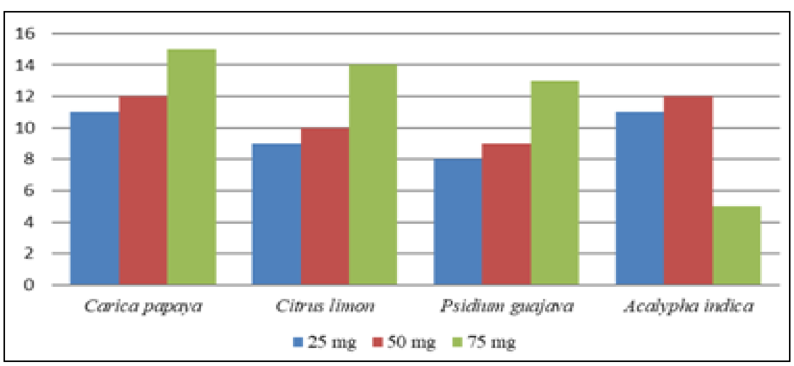

FIG. 3: ANTIFUNGAL ACTIVITY OF CHLOROFORM EXTRACTS OF PLANT LEAVES ON ISOLATED *RHIZOPUS SPECIES*

DISCUSSION: Mucormycetes are called thermotolerant molds, widely found on soil and other organic substances. High humidity and temperature of 27°C are the favorable environmental conditions required for the growth and sporulation of mucorales on these substrates. According to the literature survey, most mucormycetes are thermophilic species have been isolated from composting plant materials [35].

Today, mucormycosis is identified as an emergent disease, owing to the increasing incidence and mortality over the past two decades [36]. Diagnosis and control of mucormycosis remain challenging tasks in worldwide and no radiological signs or clinical specific have been identified for mucormycosis. Moreover, standardized antigen or serological detection tests are not currently available [37]. In previous studies, researchers have attempted to compare the identification of mucorales fungi, using molecular and phenotypic methods [38]. From the present study, all the macroscopic and microscopic characteristics of isolated colonies were observed, and isolated colonies were identified as *Rhizopus species.* From the clinical mucormycosis sample, *Rhizopus* species were frequently isolated. Additionally, members of the genus *Mucor* are second to *Rhizopus* in frequency [39].

Previous studies have shown the antifungal effect of organic extracts derived from plant sources and also has been shown that the effects of phytochemicals may vary depending on the type of solvent used. In accordance with the last, antifungal activity has been reported in polar compounds such as glycosylated flavonoids and saponins isolated from polar extracts [40, 41] and in non-polar compounds, like terpenoids [42, 43]. In the present study, antifungal activity of leaves of *Carica papaya* (papaya), *Citrus limon* (lemon), *Psidium guajava* (guava) and *Acalypha indica* (Indian nettle) were investigated by the disc diffusion method. Among these four extracts, the Ethanol extract of *Carica papaya* leaves (75mg/ml) was showed the highest zone of inhibition (20 ±0.2 mm) against isolated *Rhizopus species.* Aqueous extracts (25mg/ml) of *Acalypha indica* leaves exhibit the lowest zone of inhibition (7±0.2 mm) against *Rhizopus species*. Aqueous, ethanol and chloroform extracts of leaves *Carica papaya* and *Psidium guajava* leaves also showed antifungal activity against *Rhizopus species.* One study by [44] suggested that the antimicrobial activity of *Acalypha indica* leaves extract could be attributed to the active compounds of alkaloids and tannins. According to a study conducted by [45] the presence of bioactive compounds such as alkaloids, tannins, steroids, saponins, flavonoids, glycosides, and phenolic compounds was also detected during it phytochemical testing. Antibacterial activity leaves extract of *Carica papaya*, *Psidium guava,* and *Citrus limon* showed varying degrees of antibacterial and antifungal activity against all microorganisms tested. There are many reports of plants in the family Euphorbiaceae possessing antimicrobial activity and antifungal activity [46].

CONCLUSION: The result of this work suggests that the leaves extract of *Carica papaya* (papaya), *Citrus limon* (lemon), *Psidium guajava* (guava), and *Acalypha indica* (Indian nettle) have various medicinal properties, which may be attributed to the compounds present in these plant leaves. This study shows that all the four leaves extract has antifungal effects against isolated Rhizopus species from the soil. Even though the best antifungal activity was observed with the ethanol extract of *Carica papaya* leaves, ethanol extract of *Carica papaya* leaves can be used for future references for mucormycetes.

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CONFLICTS OF INTEREST: Nil.

REFERENCES:

1. Guevara A, Siqueira NP, Nery AF, Cavalcante LRDS, Hagen F & Hahn RC: Chromoblastomycosis in Latin America and the Caribbean: Epidemiology over the past 50 years. Medical Mycology 2021; 60(1): 062.
2. Nosratabadi M, Kordbacheh P, Kachuei R, Safara M, Rezaie S & Afshari M: Isolation of keratinophilic fungi from the soil of Greater Tunb, Abu-Musa, and Sirri islands in the Persian Gulf, Iran. Current Medical Mycology, 2017; 3(2): 13–19.
3. Eslahi AV, Hashemipour S, Olfatifar M, Houshmand E, Hajialilo E, Mahmoudi R & Ketzis JK: Global prevalence and epidemiology of Strongyloides stercoralis in dogs: a systematic review and meta-analysis. Parasites & Vectors 2022; 15(1): 1-13.

4. Osborne JCP, Basáñez MG, Gass KM, Barbre KA, Cromwell E, Unnasch T & Hill E: Predicting the environmental suitability for onchocerciasis in Africa as an aid to elimination planning Español. PLoS Neglected Tropical Diseases 2021; 15(7): 1-23.
5. Eslahi AV, Olfatifar M, Houshmand E, Johkool MG, Zibaei M, Foroutan M & Badri M: Prevalence of Strongyloides stercoralis in the immunocompetent and immunocompromised individuals in Iran: a systematic review and meta-analysis. Transactions of the Royal Society of Tropical Medicine and Hygiene 2022; 116(2): 87-99.
6. Badri M, Olfatifar M, Wandra T, Budke CM, Mahmoudi R, Abdoli A & Eslahi AV: The prevalence of human trichuriasis in Asia: a systematic review and meta-analysis. Parasitology Research 2022; 1-10.
7. Rodríguez-Lobato E, Ramírez-Hobak L, Aquino-Matus JE, Ramírez-Hinojosa JP, Lozano-Fernández VH, Xicohtencatl-Cortes J & Arenas R: Primary cutaneous mucormycosis caused by Rhizopus oryzae: a case report and review of literature. Mycopathologia 2017; 182(3): 387-392.
8. Compain F, Aït-Ammar N, Botterel F, Gibault L, Le Pimpec Barthes F & Dannaoui E: Fatal pulmonary mucormycosis due to Rhizopus homothallicus. Mycopathologia 2017; 182(9): 907-913.
9. Jangid R & Begum T: Antimycotic Activity of Some Medicinal Plants against Mucor circinelloides. BioMed Research International 2022; 2: 022.
10. Neto FM, Camargo PC, Costa AN, Teixeira RH, Carraro RM and Afonso JE: Fungal infection by Mucorales order in lung transplantation: 4 case reports. Transplant Proc 2014; 46(6): 1849-51.
11. Yang M, Lee HJ, Kim YK, Ki CS, Huh HJ and Lee NY: Identification of mucorales from clinical specimens: a 4-year experience in a single institution. Ann Lab Med 2016; 36(1): 60-3.
12. Bala K, Chander J, Handa U, Punia RS and Attri AK: A prospective study of mucormycosis in north India: experience from a tertiary care hospital. Med Mycol 2015; 53(3): 248-57.
13. Azhar A, Khan WH, Khan PA, Al-hosaini K, Owais M & Ahmad A: Mucormycosis and COVID-19 pandemic: Clinical and diagnostic approach. Journal of Infection and Public Health 2022; 15(4): 466-479.
14. Bhadania S, Bhalodiya N, Sethi Y, Kaka N, Mishra S, Patel N & Shah K: Hyperferritinemia and the Extent of Mucormycosis in COVID-19 Patients. Cureus 2021; 13(12): 1-6.
15. Lackner M, Caramalho R and Lass-Florl C: Laboratory diagnosis of mucormycosis: current states and future perspectives. Future Microbiol 2014; 9(5): 683-95.
16. Chao CM, Lai CC & Yu WL: COVID-19 associated mucormycosis – an emerging threat. Journal of Microbiology Immunology and Infection 2022; 55: 183-190.
17. Saleem AI, Alsaedi A, Alharbi M, Abdullah S, Al Rabou A & AlDabbagh M: Mucormycosis in pediatric oncology patients: a hospital outbreak investigation report. Infection Prevention in Practice 2021; 3(4) : 1-8.
18. Salem MA, Perez de Souza L, Serag A, Fernie AR, Farag MA, Ezzat SM & Alseekh S: Metabolomics in the context of plant natural products research: From sample preparation to metabolite analysis. Metabolites 2020; 10(1): 37.
19. de Araújo PR, Fonseca-Santos B, Kogawa AC, Salgado H & Chorilli M: A review of analytical methods for the determination of hypericin in foods, herbal, biological and pharmaceutical matrices. Current Pharmaceutical Design 2020; 26(36): 4648-4657.
20. Abdullah S, Oh YS, Kwak MK & Chong K: Biophysical characterization of antibacterial compounds derived from pathogenic fungi Ganoderma boninense. Journal of Microbiology 2021; 59(2): 164-174.
21. Abdullah S, Oh YS, Kwak MK & Chong K: Biophysical characterization of antibacterial compounds derived from pathogenic fungi Ganoderma boninense. Journal of Microbiology 2021; 59(2): 164-174.
22. Sergio L, Boari F, Pieralice M, Linsalata V, Cantore V & Di Venere D: Bioactive phenolics and antioxidant capacity of some wild edible greens as affected by different cooking treatments. Foods 2020; 9(9): 1320.
23. BIYIK B & Köroğlu A: Investigations of Şahtere (*Fumaria officinalis* L.) sold in the Turkey markets. Biological Diversity and Conservation 2020; 3(3): 200-08.
24. Ziaee A: Identification of Mucorales isolates from soil using morphological and molecular methods. Curr Med mycol 2016; 2(1): 13-19.
25. Mohamed MS, Abdel-Motaleb HY and Mobarak FA: Management of rhino-orbital mcormycosis. Saudi Med J 2015; 36(7): 865-8.
26. Purba, E. C: Kembang Telang (*Clitoria ternatea* L.): Pemanfaatan dan bioaktivitas. EduMatSains. Journal Pendidikan, Matematika Dan Sains 2020; 4(2): 111–124.
27. Ziaee A, Zia M, Bayat M and Hashemi J: Occurrence of important mucormycosis agents in the soil of populous areas of Isfahan and their pathogenicity in immunocompromised patients. J Pure Appl Microbiol 2016; 10(1): 81-8
28. Asker M, El-gengaihi SE, Hassan EM, Mohammed MA & Abdelhamid SA: Phytochemical constituents and antibacterial activity of Citrus lemon leaves. Bulletin of the National Research Centre 2020; 44(1): 1-7.
29. El Gengaihi SE, Mohammed MA, Aboubake DH, Shoaib RM, Asker MS, Abdelhamid SA & Hassan EM: Chemical, biological, and molecular studies on different citrus species wastes. Plant Arch 2020; 20(1): 2773-2782.
30. Venkatasaichaitanya Surapuram and William N. Setzer, Robert L: McFeeters and Hana McFeeters Antifungal Activity of Plant Extracts against *Aspergillus niger* and *Rhizopus stolonifer*. Natural Product Communications 2014; 9(11): 1603-5.
31. Sudhakar Chekur: Phytochemical analysis, antioxidant and antimicrobial activity of *Acalypha indica* leaf extraxts in different organic solvents .International Journal of Phytomedicine 2016; 8: 444 – 452.
32. Bhunu B, Mautsa R and Mukanganyama S: Inhibition of biofilm formation in Mycobacterium smegmatis by *Parinari curatellifolia* leaf extracts. BMC Complementary and Alternative Medicine 2017; 17(1): 1–10.
33. Kumari S, Kumar S, Prasad A, Sahay S, Kumar R, Minj N & Ahmad T: A study on antibiotic sensitivity test of methicillin resistant and nonmethicillin resistant *Staphylococcus aureus* from mastitic milk. Journal of Entomology and Zoology Studies 2020; 8: 77-79.
34. Ferreira MRA, Santiago RR, Silva-Rocha WP, Souza LBFCD, Faria MGI, Mello JCPD & Soares LAL: In vitro antifungal activity and phytochemical characterization of *Eugenia uniflora*, *Libidibia ferrea* and *Psidium guajava*. Brazilian Journal of Pharmaceutical Sciences 2021; 56.
35. Prakash H & Chakrabarti A: Global epidemiology of mucormycosis. Journal of Fungi 2019; 5(1): 26.
36. Brooks D, Abdessalam S, Davies HD, Aldrich AM, Bedrnicek J & Gollehon N: Invasive cutaneous

mucormycosis in an extremely preterm infant. Journal of Pediatric Surgery Case Reports 2018; 35: 52-56.

37. Rodríguez-Lobato E, Ramírez-Hobak L, Aquino-Matus JE, Ramírez-Hinojosa JP, Lozano-Fernández VH, Xicohtencatl-Cortes J & Arenas R: Primary cutaneous mucormycosis caused by *Rhizopus oryzae*: a case report and review of literature. Mycopathologia 2017; 182(3): 387-392.
38. Bowers JR, Monroy-Nieto J, Gade L, Travis J, Refojo N, Abrantes R & Engelthaler DM: Rhizopus microsporus infections associated with surgical procedures, Argentina, 2006–2014. Emerging Infectious Diseases 2020; 26(5): 937.
39. Prakash H, Ghosh AK, Rudramurthy SM, Singh P, Xess I, Savio J & Chakrabarti A: A prospective multicenter study on mucormycosis in India: Epidemiology, diagnosis and treatment. Medical Mycology 2019; 57(4): 395-402.
40. Pandey M, Singh G, Agarwal R, Dabas Y, Jyotsna VP, Kumar R & Xess I: Emerging Rhizopus microsporus infections in India. Journal of Clinical Microbiology 2018; 56(6): 00433-18.
41. Samaddar A, Sharma A, Maurya VK & Tak V: Necrotizing fasciitis caused by *Apophysomyces variabilis* in a burn patient. IDCases 2019; 18: e00660.
42. Adesso S, Ruocco M, Rapa SF, Dal Piaz F, Di Iorio BR, Popolo A & Marzocco S: Effect of indoxyl sulfate on the repair and intactness of intestinal epithelial cells: Role of reactive oxygen species' release. International Journal of Molecular Sciences 2019; 20(9): 2280.
43. Rapa SF, Waltenberger B, Di Paola R, Adesso S, Siracusa R, Peritore AF & Marzocco S: Plumericin prevents intestinal inflammation and oxidative stress *in-vitro* and *in-vivo*. The FASEB Journal 2020; 34(1): 1576-1590.
44. Saryono S, Octarina N, Yuharmen Y, Pratiwi NW & Ardhi A: Antifungal activity of the extracts and fractions of dahlia tuber (Dahlia variabilis) against pathogenic skin fungi. Nusantara Bioscience 2017; 9(2): 146-151.
45. Mohan SC, Dinakar S, Anand T, Elayaraja R, Sathiya Priya B: Phytochemical, GC-MS analysis and antibacterial activity of a medicinal plant *Acalypha indica*. Int J Pharm Technol Res 2012; 4(3): 1050-1054.
46. Cheok CY, Mohd Adzahan N, Abdul Rahman R, Zainal Abedin NH, Hussain N, Sulaiman R & Chong GH: Current trends of tropical fruit waste utilization. Critical Reviews in Food Science and Nutrition 2018; 58(3): 335-361.
47. Dosoky NS & Setzer WN: Biological activities and safety of Citrus spp. essential oils. International Journal of Molecular Sciences 2018; 19(7): 1966.
48. Díaz-de-Cerio E, Verardo V, Gómez-Caravaca AM, Fernández-Gutiérrez A & Segura-Carretero A: Health effects of Psidium guajava L. leaves: an overview of the last decade. International Journal of Molecular Sciences 2017; 18(4): 897.

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