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Identification of Saprophytic Mold Isolated from Mangrove Soil: A Review

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ABSTRACT

Saprophytic mold is one type of mold that has the ability to survive in extreme conditions, such as in mangrove soil. Saprophytic fungi act as the main organism in the process of decomposition of organic matter and energy flow in the mangrove area. The data was collected from national and international accredited journals within the past 15 years, ranging from 2005-2020. Several researchers successfully identified 102 species and 33 genera of saprophytic fungi. *Aspergillus* is known to be the dominant mold on mangrove soils because of its characteristics, such as high sporulation and spore spread and its ability to withstand extreme environmental conditions. The use of saprophytic molds in biofertilizer due to saprophytic molds can produce cellulase, xylanase, and ligninase enzymes to decompose organic matter and produce toxin compounds for pathogens in plants. The presence of mold species in mangrove soil is influenced by several factors, including the temperature level, season, the salinity of mangrove waters, soil pH, and oxygen.

1. Introduction

The development of agricultural systems in Indonesia is currently dominated by the use of chemical fertilizers, which have negative impacts both inside and outside the agricultural ecosystem environment. The long-term use of chemical fertilizers may reduce soil fertility and nutrient levels; therefore, replacing them with organic fertilizers or biofertilizers isnecessary as an alternative to solve these problems.

Biofertilizer is a material derived from living bodies, especially microorganisms, used to improve the quality and quantity of a crop's production [1]. Microorganisms composing biofertilizers consist of Nitrogen (N_2) fixing microbes, phosphate solubilizing microbes (bacteria and fungi), microbes producing growth-regulating compounds, microbes that can expand the root surface, microbes that break down organic matter (decomposers), and microbes that protect plants against pests and diseases [2]. The microorganisms that form this biofertilizer can be found in mangrove ecosystems because of its high nutrient and organic matter content that allows molds to colonize.

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One type of mold that can grow in mangrove environments is saprophytic mold. Saprophytic fungi can break down complex organic substances because they have extracellular enzymes that can convert complex components into simpler ones, such as cellulase, hemicellulase, ligninase, chitinase, and more. The ability of saprophytic mold to break down these organic compounds makes saprophytic molds can be used as a raw material for biofertilizer procurement. Compounds resulting from the decomposition of the mangroves' organic matter can provide various nutrients needed by plants, such as 25% water, 1-5% sugar and starch, 10-30% hemicellulose, 20-50% cellulose, 10-30% lignin, 10% protein, fat and others 1-8% [3]. The biomass produced is highly beneficial to other plants lacking nutrients.

Based on the description above, the identification of saprophytic fungi is necessary in order to support the procurement of biofertilizers in the community. Mold identification involves morphological characterization activities, including macroscopic and microscopic, physiological, and molecular characterization of the mold. The designation of an organism is necessary to determine its status and function in its environment. In this case, the manufacture of biofertilizer requires each constituent species to be named to ensure the accuracy of the fertilizer composition.

This study aims to determine the number of saprophytic mold species that can be isolated from mangrove soils, determine the group of saprophytic molds that are found in mangrove soils, determine the role of saprophytic molds in making biofertilizers, and determine the influence of environmental factors on the abundance and presence of saprophytic molds in mangrove soils.

2. Materials and methods

This study relies on literature studies to obtain necessary data from library sources or documents (Zed, 2014).

2.1. Data Sources

The data was collected from national and international accredited journals within the past 15 years, ranging from 2005-2020. The strategy used in the data retrieval process is by searching for journals directly through accredited online journal websites such as Science Direct, NCBI, and Research Gate. In addition, data sources were also obtained from article reference lists to identify additional relevant studies. The keywords used to search the intended journal were identification, morphology, molecular, isolation, biodiversity, Ascomycota, soil mold, saprophytic mold, biofertilizer, mangrove soil, role of saprophytic mold, temperature, season, pH, salinity, oxygen.

2.2 Research Variables

The variables of this study were the types of saprophytic mold isolated from mangrove soil.

2.3.Data Analysis

In this study, a total of 39 journals were summarized, which covered the inclusion criteria conducted between 2005-2020. Detailed information is presented in Table 1-4, which in Table 1 informs about the identity of the researcher and the species of mold that were successfully isolated. Table 2 describes the most commonly found mold genera and the reasons, table 3 describes the role of mold species as biofertilizers, and Table 4 describes the influence of environmental factors such as temperature, pH, salinity, seasonality, and oxygen on the presence and abundance of mold in the mangrove environment

3. Results and discussion

3.1 Species of mold successfully isolated from mangrove soil

Molds that grow in mangrove environments can be categorized based on their ecological roles as saprophytic, pathogenic, endophytic, phosphate-solubilizing, and cellulose-degrading. Saprophytic molds are the primary organisms involved in the process of litter decomposition and energy flow in mangrove areas (Newell, 1996).

Table 1. Species of mold successfully isolated from mangrove soil

No	References	Specieses of mold	Sources (Sampling Location)
1.	[4]	*Absidia* spp., *Acromonium* spp., *Alternaria* spp., *Aspergillus petrakii.*, *Aspergillus duricaulis.*, *Aspergillus niger* *Aspergillus versicolor.*, *Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus terreus*, *Cladosporium* spp., *Penicillium* spp., *Rhizopus* spp., *Trichoderma* spp., *Paecillomyces* spp.	Mangrove soil (across the mangrove coastal areas) at Sharm el-Sheikh in Egypt
2.	[5]	*Aspergillus niger*, *Aspergillus flavus*, *Aspergillus tamarii* *Aspergillus ochraceus*, *Aspergillus fumigatus*, *Trichoderma harzianum*, *Trichoderma reesei*, *Penicillium* spp., *Penicillium citrinum*, *Penicillium roseopurpureum*, *Mucor* spp.	Mangrove soil area of Thazhekayu in Madakkara, Kannur, Kerala
3.	[6]	*Acremonium roseum*, *Alternaria alternata*, *Aspergillus albus*, *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus oryzae* *Cladosporium oxysporum*, *Fusarium pallidoroseum*, *Fusarium solani*, *Graphium* spp., *Paecilomyces variotii*, *Penicillium chrysogenum*, *Phoma* spp., *Trichoderma Virens.*	Mangrove soil of Mahanadi delta, Orissa, India.
4.	[7]	*Aspergillus alliaceus*, *Aspergillus awamori*, *Aspergillus flavus*, *Aspergillus candidus*, *Aspergillus chevalieri*, *Aspergillus niger* *Aspergillus conicus*, *Aspergillus sydowi*, *Aspergillus nidulans* *Aspergillus granulosis*, *Aspergillus funiculosus* *Aspergillus lunchensis*, *Aspergillus rugulosus*, *Aspergillus variecolor*, *Aspergillus versicolor*, *Curvularia lunata*, *Fusarium oxysporum*, *Fusarium solani*, *Penicillium* sp., *Penicillium citrinum*, *Penicillium roquefort*, *Spicaria divaricata (Paecilomyces variotii)*, *Rhizopus stolonifer*, *Verticillium* sp.	Rhizosphere soils from mangrove environment of Arasankarai, Muthukuda, Ammapattinam, Pudukkottai District, Tamilnadu, India.
5.	[8]	*Aspergillus niger*, *Aspergillus flavus*, *Aspergillus ochraceus*, *Rhizopus stolonifer*, *Mucor hiemalis*, *Fusarium verticiloides*, *Fusarium moniliforme*, *Fusarium oxysporum*, *Botyritis cinerea*, *Trichoderma viride*, *Verticillium lecanii*, *Penicillium caseicolum*, *Penicillium brevicompactum*, *Penicillium digitatum*	Rhizosphere soil from the Eagle Island located behind the Rivers State University of Science and Technology, Nkpolu, Port Harcourt, Nigeria.
6.	[9]	*Absidia corymbifera*, *Alternaria alternata*, *Aspergillus niger*, *Aspergillus candidus*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus paraciticus*, *Aspergillus sulphureus*, *Aspergillus terreus*, *Aspergillus wentii*, *Cladosporium dadosporioides*, *Dreshlera australiensis*, *Fusarium solani*, *Monillia* sp., *Mucor* sp., *Penicillium* sp., *Rhizopus stolonifer*, *Trichoderma viride.*	Rhizosphere soil of mangrove plants (*Avicennia marina*, *Rhizophora mucronata*, *Aegiceras corniculatum*, and *Ceriops tagal*) from coastal areas, Pakistan
7.	[10]	*Acrophialophora fusispora*, *Aspergillus acuelatus*, *Aspergillus alliaceus*, *Aspergillus candidus*,*Aspergillus flavipes* *Aspergillus carbonarius*, *Aspergillus cervinus*, *Aspergillus flavus*, *Aspergillus conicus*, *Aspergillus glaucus*, *Aspergillus crystallinus*, *Aspergillus flavipes*, *Aspergillus niger*,	Rhizosphere soil from mangrove field at Karankadu, Ramanathapuram District, Tamil Nadu, India.

		Aspergillus foetidus (A.luchuensis), Aspergillus fumigatus, Aspergillus humicola, Aspergillus itaconicus, Aspergillus luteus Aspergillus ochraceus, Aspergillus phoenicis, Aspergillus sparsus, Aspergillus sulphureus,Aspergillus terreus Aspergillus terricola, Aspergillus unguis, Aspergillus versicolor Botrytis cinerea, Cephalosporium humicola, Cladosporium sp., Curvularia geniculata, Curvularia lunata, Curvularia subulata, Curvularia pallescens, Dendrophion nanum, Drechslera oryzae Fusarium equiseti, Fusarium moniliforme, Gliocladiopsis sagariensis, Mortierella decipiens, Penicillium cyaneum, Penicillium janthinellum, Penicillium javanicum, Penicillium nigricans, Penicillium purpurogenum, Penicillium purpurrescens, Penicillium terrestre, Penicillium raistrickii, Scopulariopsis acremonium, Stachybotrys chartarum, Synchepalastrum racemosum, Trichoderma harzianum, Trichoderma lignorum (T.viride), Trichoderma polysporum, Ulocladium consortiale, Verticillium arboretum	
8.	[11]	*Aspergillus fumigatus, Aspergillus protuberus, Aspergillus terreus, Aureobasidium* sp., *Chaetomium* sp., *Cladosporium* sp., *Curvularia* sp., *Fusarium* sp., *Mucor* sp., *Penicillium citrinum, Penicillium chrysogenum, Sporothrix sp., Talaromyces flavus, Trichophyton* sp., *Trichoderma* sp.	Surface sediment of Araca bay in f São Sebastião, São Paulo, Brazil.
9.	[12]	*Aspergillus fumigatus, Aspergillus paraciticus, Chrysonilia sitophila.*	Mangrove rizhosphere from mangrove forest in Sungsang, Banyuasin District of South Sumatra Province, Indonesia.
10.	[13]	*Aspergillus* sp., *Penicillium* sp.	Mangrove soil from Denpasar, Bali, Indonesia.
11.	[14]	*Aspergillus niger, Aspergillus* spp., *Chaetomium* sp., *Eupenicillum* sp., *Gliocladium* sp., *Paecilomyces* sp., *Penicillium* spp., *Trichoderma harzianum, Trichoderma* spp. *Coelomycetes* sp.	Muara Layang estuary sediment in Bangka Belitung islands, Indonesia.

3.2 The Saprophytic Mold Group that is widely found

Dominant species play a crucial role in determining the growth conditions for other species (Krebs, 1985). In communities with high species richness, it is common for only a few species to dominate a particular area while others are rare (Rabinowitz, 1981; Cooke and Rayner, 1984).

Table 2. The Saprophytic Mold Group that is widely found

No	References	The most commonly saprophytic mold genus	Description
1.	[4]	*Aspergillus*	It was found at 15 out of 24 sample points in the mangrove area of Sharm el-Sheikh, Egypt.
2.	[5]	*Aspergillus*	Of the 11 molds found in the mangroves of Kerala, India, 5 are *Aspergillus*.
3.	[6]	*Fusarium*	Of the 22 fungal species found, *Fusarium solani* was the most common at 10.75%.
4.	[7]	*Aspergillus*	The genus *Aspergillus* dominated 15 of the 25 species found.

4.	[7]	*Aspergillus, Penicillium, Trichoderma*	Found in all sampled mangrove sites in Tamil Nadu, India
5.	[8]	*Aspergillus, Penicillium*	Most common in almost all sampled southern Nigeria mangrove areas.
6.	[9]	*Fusarium*	Found in high abundance in the mangrove areas of Karachi, Pakistan.
7.	[10]	*Aspergillus*	25 species of *Aspergillus* were found out of 58 species isolated.
8.	[11]	*Aspergillus*	Of the 15 species of molds found in the soil of the mangrove area of Araca Bay, Brazil, the most common overall was *Aspergillus* sp. with 38.9%.
9.	[14]	*Aspergillus*	Of the 8 genera found, *Aspergillus* has the most species. 6 species are found in the estuary area of Muara Layang, Bangka Belitung.

3.3 The role of Saprophytic Mold in the manufacture of Biofertilizers

Saprophytic moulds are a group of fungi that can decompose organic compounds into simpler forms, providing nutrients for plants. They possess extracellular enzymes, such as cellulase, hemicellulase, ligninase, and chitinase, which enable them to break down complex organic substances. Saprophytic fungi's ability to decompose organic compounds makes them useful as raw materials for producing biological fertilizers or biofertilizers. The following are some of the roles of saprophytic moulds in creating biofertilizers.

Table 3. The Role of Saprophytic Mold

No.	References	Saprophytic mold	Activities
1.	[15]	*Aspergillus* and *Penicillium*	Phosphate solubilizer that can increase soluble phosphate by 27-47% in acid soils.
2.	[3]	*Aspergillus*	*Aspergillus niger* and *Aspergillus parasiticus* are capable of decomposing lignin and cellulose compounds, dissolving inorganic phosphate compounds into organic ones, and producing the growth hormone IAA.
3.	[16]	*Rhizopus* sp.	*Rhizopus sp.* plays a role in the decomposition process of organic matter by breaking down lignin, fat, cellulose, and carbohydrates found in plants.
4.	[15]	*Trichoderma* sp.	can be used to produce toxic substances that can be used to control the growth or development of harmful organisms.
5.	[17]	*Penicillium* dan *Aspergillus*	Inoculation of *Penicillium* and *Aspergillus* can increase the growth of plants grown in soils with 2% salinity.
6.	[18]	*Penicillium* and *Aspergillus*	*Penicillium* and *Aspergillus* can increase the growth of eggplant plants. Penicillium has ligninase enzyme activity to degrade lignin and provide carbon (C). Meanwhile, Aspergillus has cellulase enzyme activity for cellulose degradation.
7.	[19]	*Chaetomium*	*Chaetomium* has the ability to decompose leaf litter in a short period of time due to its high cellulolytic activity

8.	[20]	*Cladosporium*	*Cladosporium* sp. isolated from Kuch soil, Gujarat, India is capable of producing lipids, fatty acids and proteins.
9.	[21]	*Mucor* and *Chaetomium*	*Mucor* and *Chaetomium* can produce cellulase, ligninase, and xylanase to degrade organic matter.

3.4 The Influence of Environmental Factors on the Presence and Abundance of Mold in Mangrove Soil

The abundance and presence of mold species in mangrove soils are influenced by several factors, including the salinity of mangrove waters, the nature of mangrove soil (mud or sand), soil pH, oxygen supply, moisture, soil temperature, nutrient content, and the amount of soil organic matter (Agate *et al.*, 1988). It is important to note that the following environmental factors have an impact on the abundance and presence of molds in mangrove soils.

Table 4. The Effect of Environmental Factors on the Presence and Abundance of Mold

No.	Environmental Factors	References	Influence of Environmental Factors on Mold Presence and Abundance
1.	Temperature	[22]	The study of 126 soil samples at different temperatures showed that the ambient temperature has a great influence on the variation of the microbial diversity in the soil.
		[23]	Temperature is an important factor in the control of the growth and activity of soil microbes.
		[24]	Higher temperatures can accelerate the decomposition process, reducing the availability of nutrients that can support the growth of soil microbes.
2.	Season	[11]	The density of filamentous molds isolated from mangrove soils in Araca Bay, Brazil, was higher in winter than in summer. The most abundant mold genera in winter were *Penicillium* and *Aspergillus*, and the most abundant mold genera in summer were *Aspergillus*, *Cladosporium*, and *Trichoderma*.
		[25]	The biodiversity of fungi isolated from mangrove soils in Ranong was highest during the rainy season, followed by winter and summer.
		[26]	The diversity of fungi in the Andaman Mangrove Forest, Ranong Province, is higher in the wet season than in the dry season.
		[27]	The density of mold populations in mangrove soils occurs during the wet (rainy) season when soil moisture is significantly increased.
3.	Salinity	[28]	The diversity of rhizosphere molds in semi-arid mangrove soils was influenced by salinity. The most abundant mold genera in high salinity samples were *Aspergillus, Saitozyma, Trichoderma, Podosphaera*, and *Cystofilobasidium*. In low-salinity samples, the

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			most abundant genera were *Amorosia*, *Phaeoacremonium*, *Aspergillus*, *Talaromyces*, and *Trichoderma*.
		[29]	The composition of molds varied with salinity, with intermediate salinities showing the greatest abundance of molds.
		[30]	Soil with high salinity can reduce the amount of PLFA (phospholipid fatty acid), which is part of the cell membrane, while maintaining membrane integrity in mold. Thus, high salinity can cause a decrease in mold.
		[30]	Compared to bacteria, molds are more sensitive to changes in salinity. The abundance of mold decreased as salinity decreased.
4.	pH	[31]	Mold growth increases at pH 4.5 to 8.5. Mold growth decreases at pH 4.5 to 4.0. Mold growth is maximized at pH 4.5.
		[32]	A pH range of 4-7 (from neutral to acidic) is most conducive to the growth of various soil molds.
		[33]	pH determines the balance of molds in the soil. A low pH is more conducive to mold growth than bacteria. Soil pH also affects the organic matter in the soil.
5.	Oxygen	[34]	The top layer of soil (0-30 cm) contained a higher number of Arbuscular Mycorizal mold propagules compared to soil samples analyzed from deeper layers. The lower spore population in the deeper layers is due to lower oxygen levels.
		[35]	AMF (Arbuscular Mycorizal Fungi) composition changes with increasing soil depth. Differences in the composition of fungi at several levels of soil depth occur, possibly due to the influence of the availability of organic content and oxygen.
		[25]	The number of molds isolated from the soil surface was higher than in the waterlogged soil. This is because oxygen levels are a limiting factor for mold populations.

Discussion

Mold identification involves morphological characterization activities, including macroscopic and microscopic characterization of the mold, physiological characterization, and molecular characterization. Based on the molecular identification that has been done by several researchers around the world (Table 1.), it is known that mold species that have been successfully isolated from mangrove soil are 102 species from 33 different mold genera, namely *Acrophialophora, Absidia, Acremonium, Alternaria, Aspergillus, Botrytis, Chaetomium, Chrysonilia, Cephalosporium, Cladosporium, Coelomycetes, Curvularia, Dendrophion, Drechslera, Eupenicillium, Fusarium, Gliocladiopsis, Graphium, Monilia, Mucor, Paecilomyces, Penicillium, Phoma, Rhizopus, Sporothrix, Scopulariopsis, Stachybotrys, Synchepalastrum, Thamnidium, Trichoderma, Trophyton, Ulocladium,* and *Verticillium.* The majority of molds isolated from mangrove soil are Ascomycota mold groups. This is because the Ascomycota group has spores that can adapt to mangrove substrate conditions. Ascomycota is also a common mold group in intertidal mangrove areas. Ascomycota molds are also saprophytes, and several studies have found that Ascomycota can produce most enzymes to degrade complex substrates, including cellulose, keratin, and collagen [36], [37]. This makes the existence of Ascomycota essential in decomposing and recycling nutrient soils [38].

The Ascomycota mold group is most commonly found in mangrove land areas or is the dominant species, *Aspergillus*. This is in accordance with the data listed in (Table 2) which shows the dominance of the mold in the mangrove soil environment. The dominance of *Aspergillus* occurs because of its high level of sporulation and spore dispersal and its high level of resistance to extreme environmental conditions [39]. *Aspergillus* can also produce high tannase enzymes that degrade tannins in mangrove leaves. In addition, the mold also has a high cellulolytic activity related to its function in decomposing cellulose and hemicellulose in the litter-rich mangrove rhizospheres [40]. The abundance of *Aspergillus* is more dominant than other molds because *Aspergillus* can generally grow at high temperatures and with low water content. *Aspergillus* mold also has a high resistance to various levels of salinity so that it can dominate the mangrove soil area more than other mold species. This is in accordance with the research of [41], who isolated molds from the soil and estuary of the Ganges River in India with low salinity conditions (11-15) and the most commonly found genus is *Aspergillus*.

The presence of saprophytic molds in mangrove environments is known that saprophytic molds have several roles in making biological fertilizers or biofertilizers, such as producing cellulase, ligninase and xylanase to degrade organic matter, play a role in phosphate solvents, and produce substances used to inhibit the growth of plant pathogens. With the capabilities that saprophytic fungi have, this can certainly provide an excellent opportunity to make improvements to plants that require adequate levels of nutrients and biological control of plants from disease attacks through the manufacture of biofertilizers.

Based on (Table 4), it is known that there are several influences of environmental factors such as temperature, season, salinity, pH, and oxygen on the presence and abundance of mold in mangrove soil. Temperature strongly correlates with the taxon richness and diversity of soil molds, and plays an essential role in controlling microbial growth and activity. A rise in temperature has the most significant effect on increasing an organism's metabolism, which in turn increases population growth and multiplication. In terrestrial environments such as mangroves, high temperatures can increase the productivity of the ecosystem, resulting in more species. The high productivity of mangrove ecosystems can provide many substrates so that microorganisms can use them as nutrients. Thus, the diversity of microorganisms will also be higher. Higher temperatures can also accelerate the decomposition process and, therefore, affect the availability of nutrients that can support soil microbial growth. However, in this case, the moisture content of the soil (substrate) is also responsible for the diversity of microorganisms in mangrove soil because on a dry substrate, the growth of fungi will be inhibited [24], [42].

The season is also a contributing factor that affects the abundance and presence of mold in mangrove soil. From several studies above, it is known that the highest mold diversity and density occurs in the rainy season. This is because during the rainy season, soil moisture will significantly increase. In addition, soil salinity is also a factor in the presence and abundance of mold in mangrove soil. This is because soil salinity is a key characteristic of mangrove soils as a result of direct exposure to seawater during tidal periods. Mangrove soil commonly has a high level of soil salinity [43]. The level of salinity in the mangrove environment can affect the composition of mold in the soil. This is because mold is an organism that is sensitive to osmotic stress as indicated by the decrease in the proportion of PLFA (Phospholipid Fatty Acid), which is part of the cell membrane that maintains membrane integrity in mold when in high salinity. With the decrease in the proportion of PLFA, the number of molds decreased [30].

Soil pH also affects the presence and abundance of mold in mangrove soil because each type of mold has a different pH range. Mangrove environments that contain soils with pH levels of 6-7 tend to be acidic to 7-10 in mangroves in coastal areas. Mold growth increases at pH between 4.5-8.5 and decreases in the pH range of 4.5-4.0 with maximum growth at pH 4.5. Compared to bacteria, molds have the ability to grow at low pH; this is also due to the presence of PLFA (Phospholipid Fatty Acid), which allows molds to adapt to extreme environments by maintaining membrane integrity [31].

The factor that affects the presence and abundance of mold in mangrove soil is oxygen. Oxygen is required for decomposers to decompose organic matter. In this case, the mold is a decomposer of organic matter. In soil, soil depth affects the levels of organic matter; the highest levels of organic matter are found in the upper soil layers, and the lower it is, the less organic matter content is present in the soil. In an environment with high organic matter, oxygen availability increases because decomposers need oxygen to break down organic matter. The topsoil (0-30 cm) contained more Mycorrhizal Arbuscular mold propagules compared to soil samples analyzed from deeper layers. Lower oxygen levels cause fewer spore populations in the deeper layers. Therefore, in the upper soil layer with a high oxygen content, the density of mold is also high, and along with the addition of soil depth, the presence of mold is also lower [34], [44].

4. Conclusions

From the results of this journal review, it can be concluded that : (1) The saprophytic mold species that can be isolated from mangrove soil are 102 species from 33 different mold genera, namely *Acrophialophora, Absidia, Acremonium, Alternaria, Aspergillus, Botrytis, Chaetomium, Chrysonilia, Cephalosporium, Cladosporium, Coelomycetes, Curvularia, Dendrophion, Drechslera, Eupenicillium, Fusarium, Gliocladiopsis, Graphium, Monilia, Mucor, Paecilomyces, Penicillium, Phoma, Rhizopus, Sporothrix, Scopulariopsis, Stachybotrys, Synchepalastrum, Thamnidium, Trichoderma, Trophicyton, Ulocladium*, and *Verticillium*. (2) The most common mold groups found in mangrove soil are from the *Aspergillus* genus, (3) Some of the roles of saprophytic mold in making biological fertilizers or biofertilizers are to produce cellulase, ligninase, and xylanase to degrade organic matter, playing a role in phosphate solvents, and producing substances used to inhibit the growth of plant pathogens, and (4) Environmental factors that can affect the abundance and presence of saprophytic mold in mangrove soil include temperature, season, salinity, pH, and oxygen.

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Not available

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