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Review Article

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Review on Biodiversity of fungi in Marine and Mangrove fungi

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Introduction

Rabiyathul *et al*. (2018) isolated 19 morphologically different fungi from mangrove rhizosphere soil sediment, Pichavaram mangrove forest. The fungi were identified and characterized based upon their microscopic examination and cultural characteristics on media. The study concluded that Pichavaram mangrove forest was the potential source for fungal populations.

Zhou *et al.* (2016) isolated 195 strains of marine fungi from three different habitats such as beach habitats, estuarial habitats and mangrove habitats. Antibacterial activity was done by disc diffusion method.The results showed that fungi isolation from the mangrove habitats had stronger antibacterial activity than the other two habitats.

Prakash and Sivakumar, (2013) isolated fungi from water, sediment, sea foams and natural substrates from mangrove habitat of Muthupet. Screening and activity of fungal enzymes like pectate, lyase, lipase, xylanase and lipase were studied.18 species of fungi were showed zone of clearance for laccase followed by xylanase (16 sp.), lipase (13 sp.), pectate and lyase (12 sp.)

33 isolates of *Fusarium* sp. were isolated using different isolation techniques from soil samples collected from a mangrove forest located atPulau Pinang, Malaysia. Among the various techniques used, the debris isolation technique yielded the most isolates with a total of 22 *Fusarium* isolates. *F. solani*(91%) was the most common species recovered from the mangrove soil samples, followed by *F. oxysporum*(6%) and *F. verticillioides* (3%). (Zakaria Ltiffah *et al*., 2010)

Nine morphologically different fungal strains were isolated from sediment samples collected from Sundarban mangrove forest. They were identified up to the genus level (*Aspergillus, Penicillium* and *Fusarium*). Antibacterial activity was performed by agar plug method in which four fungal isolates [SF2, SF5, SF7 and SF8] showed good antibacterial activity. Manikkam Radhakrishnan *et al*. (2011) revealed that Sundarban mangrove forest is the potential source for antibacterial compounds.

Gayatri Nambiar and Raveendran, (2009) isolated twenty-six manglicolous marine fungi comprising 20 ascomycetes, 1 basidiomycete and 5 mitosporic fungi were isolated from the mangrove forests of Kerala, South India. Average isolates per wood sample and percentage colonization were 1.54 and 81.25 respectively. Based on the percent frequency of occurrence, *Lulworthia grandispora* (13.19%), *Dactylospora haliotrepha* (12.09%), *Savoryella lignicola* (10.99%) and *Cirrenalia pygmea*(10.99 %) were the most frequent species.

30 fungi were isolated from Godavari and Krishna delta Mangroves. *Aspergillus, Penicillium, Curvularia*sp and *Drechslera*sp were isolated both from Godavari and Krishna deltas. *Alternaria, cladosporium, Nigrospora, Trichoderma, Alleschriella* were isolated only from Krishna deltas. (ChldKaruna *et al*., 2009)

Sarma and Vittal, (2001) sampled nine host plant species of *Avicennia marina, Avicennia officinalis, Aegicerias corniculatum, Rhizophora apiculata, Exoecaria agallocha, Lumnitzera racemosa, Sonneratia apetala, Acanthus ilicifolius* from Godavari and Krishna deltas, Andhra Pradesh. It resulted in identification of 88 marine fungi. Of these 65 belonged to Ascomycetes,1 Basidiomycete and 28 mitosporic fungi of which 6 species belonged to Coelomycetes and 16 species to Hyphomycetes. *Verruculinaenalia*was the only fungus species found commonly on all the nine mangrove plants.

Kandikere Sridhar, (2009) reported the damp incubation of wood, root and leaf litter of *Avicennia marina* and *Rhizophora mucronata*. The fungal richness was highest (9 spp.) on woody litter of both plant species and root litter of *R. mucronata*. *Aniptoderachesa peakensis, Halorosellinia oceanica, Halosarpheia marina, Periconia prolifica* and *Phoma*sp. were dominant (5-6.3%). Woody litter of *A. marina* was highly colonized by *H. marina* (28%), while *R. mucronate* by *Phoma*sp. (24%). The average fungi per sample ranged between 0.3 and 0.8 with a highest on woody litter (0.7-0.8). Further the study was exploited 10 niches (water, sediment and live/dead plant parts) and 14 mangrove plant species. About 102 fungi consisting of mitosporic fungi (57 spp.), Ascomycetes (37 spp.), phycomycetes (7 spp.) and Basidiomycete (1 sp.) have been reported. Woody litter yielded a highest of 36 saprophytic fungi followed by 33 fungi as foliar epiphytes. *Cirrenalia pygmea* was the most dominant fungus, followed by *H. oceanica, P. prolifica*, *Zalerion maritima* and *Z. varia*. The foliar endophyte, *Sporormiella minima* colonized the highest number of mangrove plant species.

Samuel and Prabakaran, (2011) determined the diversity of marine fungi colonizing the sediment samples collected from the intertidal regions of the Adirampattinam coast. Thirty-six marine fungi species belonging to 19 genera comprising 31 Ascomycota, 2 Mucoromycotina, 2 Hyphomycetes and 1 Zygomycetes were reported. Among those species *Aspergillus fumigatus* was recorded as common, *Penicillium luteum, Penicillium expansum, Penicillium granulatum, Geotrichum candidum, Acremonium sp and Aspergillus flavus* as frequent, *Acrophilophra fusispora, Absidiaglauca* sp. and *Fusarium oxysporum* as occasionally and the remaining species as rare.

29 species of typical marine and mangrove fungi were isolated from wood substrates of by using baiting technique. Among the 29 isolates, 12 fungal species such as *Lophiostoma mangrovei, Lulworthia grandispora, Camarosporium roumeguerii, Quintaria lignatilis, Trematosphaeria lineolatispora, Pleospora triglochinicola, Clavatospora bulbosa, Torpedospora ambispinosa, Trimmatostroma sp. Leptosphaeria peruviana, Massarina armatispora* and *Aniptoderachesa peakensis* were isolated first time from the mangrove ecosystems. (Sivakumar and Ravikumar, 2014).

27 endophytic fungi were isolated from young mature and senescent leaves of *Suaeda monoica*. *Aspergillus* was dominant community. The senescent leaves 19 species were found to more endophytic diversity than the young 9 species ones. *Aspergillusconicus, Penicillium janthinellum, Phomopsis amygdale* were occurred on young, mature and senescent leaves. (Bharathidasan and Panneerselvam, 2015)

Bharathidasan and Panneerselvam, (2015) screened endophytic fungi of the mangrove plant *Avicennia marina* (Forsk) for antibacterial activity. Endophytic fungi such as *Aspergillus awamori, Aspergillus favipes, Aspergilluschevalieri, Aspergillusflavus, Aspergillus clavatus, Aspergillus fumigatus, Penicillium candidum, Penicillium japonicum, Penicillium pupurogenum, Phoma sp.* and *Aspergillus flavus* were isolated. *Bacillus subtilis, Enterobacter*

aerogenes. Enterococcus faecalis Escherichia coli and *Klebsiella oxytoc*a were used as the test bacteria. The results showed moderate antibacterial activity.

Lin *et al.*, (2006) isolated 55 endophytic fungi from four medicinal semi-mangrove plants for antibacterial activity. *Escherichia coli, Staphylococcus aureus* and *Candida albicans* were used as the test organism. Antibacterial activity was done by well diffusion method. The results revealed that 15 strains showed significant antibacterial activity.

ChaeprasertSukanyanee *et al.* (2010) examined the distribution of endophytic fungi in the leaves of mangrove forest trees growing at three different locations (Chanthaburi Province, PrachuapKhiri Khan Province and Ranong Province) Three thousand and nine-hundred leaf segments from 10 different hosts belonging to seven families, were screened for the presence of fungal endophytes. 71 fungal strains were isolated. The isolated fungal strains were checked for their antibacterial efficacy. *Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli* and *Staphylococcus aureus* was tested using ethyl acetate extracts of fungi. The results showed significant antibacterial activity. The isolates were also tested for anticancer activities by the MTT assay against A375 (human malignant melanoma), SW620 (human colorectal adenocarcinoma), Kato III (human gastric carcinoma), HepG2 (human liver hepatoblastoma) and Jurkat (human acute T cell leukemia). The fungal isolates showed moderate cytotoxic activity.

Rajamani *et al.* (2018) reported fungal endophytes from 20 obligate mangrove hosts. *Phomopsis* / *Diaporthe* were isolated from all the mangrove species studied while *Xylaria, Colletotrichum* and *Phyllosticta* were recorded from the majority of the mangroves.

The antibacterial activity of the endophytic fungi from *Acanthopanaxsenticosus* and their secondary metabolites were investigated. *Bacillus subtilis, Bacillus pumilus, Staphylococcus aureus, Enterococcus facalis, Enterococcus faecium, Listeria monocytogenes, Streptococcus pyogenes, Escherichia coli, Pseudomonas aeruginosa, Acinetobacter baumannii, Klebsiella penumoniae* and *Candida albicans* were the test bacteria. Antibacterial activity was done by colony disc method and paper disc diffusion method. Among the 47 isolates, 37 isolates showed significant antibacterial activity.(Zheng *et al.*, 2009)

Zheng *et al.* (2009) isolated 36 endophytic fungi from *Schisandra chinensis* (Turcz.)Baill. and their secondary metabolites for antibacterial activity. *Escherichia coli, Bacillus subtilis, Staphylococcus aureus, Bacillus pumilus, Pseudomonas aeruginosa, Listeria monocytogenes, Klebsiellapenumoniae, Acinetobacterbaumannii, Streptococcus pyogenes, Enterococcus faecium, Enterococcus facalis*and *Candida albicans* were the test bacteria used. Antibacterial activity was done by colony disc method and paper disc diffusion method. Among 36 isolates, 33 isolates showed moderate antibacterial activity.

46 strains of endophytic fungi were isolated from *Glycyrrhizauralensis* Fisch. and their secondary metabolites were examined for their antibacterial efficacy against human pathogens such as *Escherichia coli, Bacillus subtilis, Staphylococcus aureus, Bacillus pumilus, Pseudomonas aeruginosa, Listeria monocytogenes, Klebsiella pneumonia, Acinetobacter baumannii, Streptococcus pyogenes, Enterococcus faecium, Enterococcus faecalis* and *Candida albicans*. Antibacterial activity was done by colony disc method and paper disc diffusion method. 34 strains showed antibacterial activity. The secondary metabolites of 20 strains had significant antibacterial activity. (Wu *et al*., 2014)

Chandralata Raghukumar *et al.* (2004) has obtained several fungal species from marine inhabitants. *Aspergillu sniger* produced some crude extract of xylanase that showed the high activity. Cellulase-free and unique properties containing 580 U l^{-1} xylanase, could bring about bleaching of sugarcane bagasse pulp by a 60 min treatment at 55ºC.

Gayatri Nambiar and Raveendran (2009) investigated on the diversity of marine fungi from two back waters of Kerala resulted in the isolation of 20 marine fungi. Out of 20, 12 belongs to Ascomycetes, 1 Basidiomycete and 8 Mitosporic fungi. Eight species were found to be common in both the backwater. They are *Aniptoderachesa peakensis, Lignincola tropica, Marinosphaera mangrovei, Savoryella lignicola, S. paucispora, Verruculin aenalia, Periconia prolifica* and *Trichocladiuma chrasporum.*

Gilna and Khaleel *et al.* (2011) isolated five fungi from mangrove soil. The isolated fungal strains were then identified by morphological, cultural and microscopic examinations. The identified strains belong to *Aspergillus* spp and *Trichoderma* spp. All the strains were assessed for the production of extracellular enzymes (amylase, protease, lipase, cellulase, and tannase) by culture plate method.

171 endo lichenic fungi were isolated from mangrove and mangrove associated plants. 70 isolates were identified by rDNA-ITS region sequence homology to the GenBank accessions and a phylogenetic analysis was performed. *Aspergillus, Byssochlamys, Talaromyces, Diaporthe, Phomopsis, Endomelanconiopsis, Schizophyllum, Cerrena, Trichoderma, Xylaria, Hypoxylon, Daldinia, Preussia, Sordaria, Neurospora, and Lasiodiplodia* were the identified fungal isolates. Ehyl acetate was used as the solvent for determining antioxidant activity, antilipase activity and α-amylase inhibition activity in *in-vitro* conditions. *Daldiniaes chscholtzii, Diaporthemusigena* and *Sordaria* sp. had the highest radical scavenging activity. Antilipase assay revealed that 13 extracts showed significant antiobesity activity. (MadurangaKasun *et al*., 2018)

New genera and new species of mangrove fungi described from the mangroves of Indian Peninsula

FUNGUS	MANGROVE	IDENTIFIERS
Acrocardiopsis patili	Maharashtra	Borse and Hyde, 1989
Aigialusman grovei	Maharashtra	Borse, 1987
Aigialusrhi zophorae	Maharashtra	Borse, 1987
Aniptodera indica	Karnataka	Ananda and Sridhar, 2001
Asterosphaeriella mangrovis	Maharashtra	Kohlmeyer and Vittal, 1986
Bathyascusman grovei	TamilNadu	Ravikumar and Vittal, 1991
Biatriospora marina	Maharashtra	Hyde and Borse, 1986
Didymellaa vicenniae	Maharashtra	Patil and Borse, 1985
Julellaa vicenniae	Maharashtra	Borse, 1987
Passeriniellaman grovei	Karnataka	Maria and Sridhar, 2002
Tirisporaman doviana	Goa	Sarma and Hyde, 2000

Swati Sinha and MitaVakilwala, (2016) screened fungi for amylase production. The optimum temperature of amylase was observed at 30°C, optimum pH 6.0 and maximum incubation period of amylase was seen at 72 hrs. Sucrose and urea were used as the carbon source and nitrogen source respectively for optimum maximum production of amylase from isolate S2(*Aspergillus* sp.).

Thirty endophytic fungi were isolated from the plant *Alpinia calcarata*(Haw.) Roscoe for amylolytic activity on glucose yeast extract peptone agar (GYP) medium. *Cylindrocephalum*s p. showed highest amylolytic activity and was taken for further study. The maximal amylase production was found to be at 30ºC and at pH 7.0 of the growth medium. Maltose at 1.5% and Sodium nitrate at 0.3% were used as carbon and nitrogen sources for optimum amylase production.(Sunitha *et al*., 2012)

SudarkodiChandrasekaran *et al.* (2015) isolated six fungi from paddy field soil, Mannargudi for production of protease enzyme. *Aspergillus flavus* showed maximum protease production at pH 8.0 and temperature 30ºC whereas *Aspergillus niger* showed maximum production at pH 7.0 and temperature 35°C.

Milala *et al*. (2016) studied the production and optimisation of protease from *Bacillus subtilis* and *Aspergillusniger*. The time course for the production of protease by both isolates was found to be maximum at 48 hours. *Bacillus subtilis* showed maximum enzyme production at pH 8.0, temperature 40˚C, whereas *Aspergillus niger* showed maximal production atpH 4.0 and temperature of 60˚C. When carbon source was decreased, a significant decrease in protease activity was observed by both the isolates.
Bacterial (*Bacillus*) and Fungal (*Aspergillus*) strains were used for the production of amylase enzyme. The optimum temperature and pH for amylase production by bacterial species was observed at 35^0C and 7. The optimum temperature and pH for amylase production by fungal species was observed at 25^0C and pH 6. Urea was the nitrogen source used for optimal enzyme production for both bacterial and fungal species. The enzyme was purified by ammonium sulphate precipitation and dialysis method and it was then analysed by SDS-PAGE. (Prasad and Sushant Sekhar, 2013)

Aspergillusniger was investigated systematically in controlled batch cultures for maximum production of protease enzyme. Optimum pH of 4 and ammonium as nitrogen source was used. (MachteltBraaksma *et al*., 2009).

Aspergillus flavus, *Aspergillus niger*, *Aspergillus umigatus* and *Penicillium italicum* produced maximal protease enzyme between day three and day five of incubation while the effect of temperature and thermal stability on the enzyme production showed temperature optimal for enzyme production was between 30 and 60^0C and the thermal stability on the enzyme activity was between 30 and 50^0C. The optimal pH was between pH 3.5 and 5.5. (Oseni, 2011)

Penicillium purpurogenum BKS9 was used with different agro waste substrates for the production of enzymes, amylase and protease by liquid static surface fermentation (LSSF). Among the various substrates tested, wheat bran (WB) was found to be the best substrate for maximum (112.64 U/ml) amylase production whereas soya powder (121.23 U/ml) for production of protease. (Bijay Kumar Sethi *et al*., 2017)

Fungi was isolated from forest soil sample for pectin enzyme production. Five fungal strains were selected for the production studies based on the rate of zone of clearance on the pectin agar plates by using Congo red test. Maximum pectinase activity was shown by *Mortierella* sp. (5.38 U/mL) followed by *Syncephalastrum recemosum* and *Aspergillus fumigatus*. (Banakar Shivakumar and Basaiah Thippeswamy, 2012).

Weiyang Liu*et al.*, (2018) isolated the compounds *β*-tetralonyl glucoside, methylberchemiaside from a fungus *Colletotrichum* sp. GDMU-1 derived from the leaves of *Santalum album*. Their structures were determined by spectroscopic analysis. Anti-inflammatory activity was done to check the efficacy of the separated compounds. The results revealed that the compounds had significant anti-inflammatory activity.

The polyhydroxylatedergostane-type sterol 9, its derivatives 10–15, and the fatty acid esters 1–8 were isolated from a fungus strain exhibited potent cytotoxic activity, and was identified as *Aspergillus awamori.* The structures of 1–15 were elucidated by spectroscopic and chemical methods. (Hao Gao Kui *et al.*, 2007).

Sawdust was used as lignocellulosic substrates for the production of cellulase enzyme using *Aspergillus fumigatus* isolated from mangrove soil after pretreatment with 4% sodium hydroxide. Parameters like pH, temperature, nitrogen sources and inducers were optimized for the cellulase production. (Gilna and Khaleel, 2010).

Youliang Huang *et al.* (2004) confirmed that an extracellular lipase from *Geotrichum marinum* was purified 76-fold with 46% recovery using Fast Flow and Bio-Gel chromatography. The purified enzyme showed a prominent band on SDS-PAGE and a single band on native PAGE based on the activity staining. The molecular mass of the lipase was estimated to be 62 k Da using SDS PAGE and Bio-Gel chromatography, indicating that the lipase likely functions as a monomer. The pI of the lipase was determined to be 4.54.

MervatMorsy El-Gendy, (2009) isolated many endophytickeratinolytic fungal isolates from marine soft coral *Dendronephthya hemprichii. Penicillium spp*. Morsy1 was selected as the hyperactive keratinolytic strain compared to the other isolated strains under solid substrate fermentation of different agriculture and poultry wastes. Maximum keratinase activity (1,600 U g^{-1}, initial dry substrate) was recovered from moldy bran with 0.1% Tween 80.
Sideney Becker Onofre *et al*. (2013)isolated the endophytic fungus, *Penicillium digitatum*, strain D1-FB from *Baccharisdra cunculifolia* D.C. (Asteraceae). The maximum yield of the enzyme was observed with SSF, using rice bran as substrate after 72 h of fermentation, with 1,625 U/mL. The α-amylase had an optimal pH at 6.5 and optimal temperature at 37°C. All the ions resulted in a decrease in the activity of α-amylase in the concentration of 5 mM. The enzyme proved to be quite stable in a pH range of 6.0 to 7.5 and up to the temperature of 37°C.

73 endophytic fungal isolates from medicinal plant *Butea monosperma* were evaluated for their antimicrobial property and enzyme producing potential. Eleven endophytic fungal isolates were found to secrete antifungal compounds inhibiting conidial germination of plant pathogenic fungi. Differences were observed among the endophytic fungal isolates in their antifungal activity. Two isolates of Morphotype-1 (BM 8 and BM 56)showed distinct antifungal activity in conidial germination

inhibition assay. Isolates of *Fusarium* spp.,*Colletotrichum* sp. and *Sclerotium* sp. were also effective against many target fungi. Three isolates of endophytic fungi showed antifungal activity against human pathogenic fungi. Five isolates of endophyticfungi were found to be antibacterial against Gram positive bacteria in agar well diffusion assay. The isolate of *Aspergillus fumigatus* (BM 6) showed antibacterial activity against both Gram positive and Gram-negative bacteria. Ability of endophytic fungal isolates to produce amylase, cellulase and pectinase was assessed in plate assay. Highest amount of all the enzymes were found to be produced by *Cladosporium* sp. as indicated by enzyme index. A range of enzyme activity was shown by isolates of*Fusarium verticillioides*, *Colletotrichum* sp., *Sclerotium* sp., *Pithomyceschartarum*, *Curvularialunata*Morphotype-1, Morphotype-2 and Morphotype-3. (DarshanTuppad and Shishupala, 2014)

*Aspergillus niger*S - 4, a mangrove isolate, and *Aspergillus oryzae* NCIM 1212 were evaluated using wheat branas substrate in solid-state fermentation (SSF). The protein and glucosamine contents and direct weight of the fungi were determined for 21 days and were found to vary significantly (P<O.O5) with the duration of SSF. *A. oryzae* can be effectively utilized for production of metabolites as well as nutritional enrichment. (Asha-Augustine *et al*., 2006)

The production and optimization of enzyme cellulose was studied from two different categories of microbes from two environments: marine fungi and mangrove actinomycetes. A total of three fungal strains were isolated from the selected marine sample (VF1, VF2, VF3) from Veli, coas and 4 strains were isolated from the Veli Mangrove samples (M1, M2, M3 and M4). For the activity of enzyme studied, the marine fungi showed the following results: neutral pH was found to be better for the production at 37°C and activity of the enzymes (VF2 and VF3) and 12th day showed the maximum production. One of the isolates (VF1) showed highest production. In case of mangrove actinomycetes, a total of the three strains of actinomycete isolates from mangrove ecosystem (M1, M2 and M4), showed Cellulase activity. M1 showed maximum activity at pH4, 50°C and 9th day of incubation. Strain M3 and M4 showed maximum production at 4 pH, 37°C and 3rd day of incubation. (AyonaJayadev *et al*., 2016)

Totally 4 different groups of fungi were isolated from the lichen *Roccellamontagnei*. Among the four genera, *Aspergillusniger* (*A. niger*) is potential to produce chitosan (1.3 g/L) on the twelfth day of incubation. Glucose plays an important role in the productivity of chitosan and the yield was maximum at 10% (1.93 g/L). Antibacterial activity revealed that *Vibrio cholerae* was sensitive to chitosan followed by *Escherichia coli*.(Logesh *et al*., 2012)

A brown-rot fungus, *Laetiporus sulphurous* (Fr.) Murr., was isolated from Mbweni, Oyster Bay and MtoniMangove Forests in Dar es Salaam, Tanzania, and the biochemical properties of its extracellularenzymes were investigated. The crude culture filtrate was concentrated by ultrafiltration. Proteincontent and lignocellulolytic enzyme activities were measured by photometric methods. The crudeenzyme extract was purified by gel chromatography and characterized by sodium dodecylsulphatepolyacrylamidegel electrophoresis (SDS-PAGE). The fungal filtrate had maximum manganeseperoxidase (MnP) of 2.5 U/mL and lignin peroxidase (LiP) of 1 U/mL, but showed no laccase (Lac)activity. The enzyme extracts were able to oxidize rhemazol brilliant blue-R (RBB-R) dye and phenol,and could remove up to 90% color from raw textile effluent in immobilized culture. The purifiedperoxidases showed that the MnP from *S. sulphurous* has a molecular weight of 48 kDA. The studyelucidated the extracellular enzymes profile of facultative marine *L. sulphurous* and provided basicinformation on their potential for biological wastewater treatment systems. (GodlivingMtui and Rose Masalu, 2008)

Based on CMC-Congo red plate-based assay, two fungal isolates derived from mangrove trees (JB10 and JB11) showed high enzymatic indices (as high as 5.6 ± 0.18 for JB10). Both isolates were then grown in potato dextrose (PD), carboxymethylcellulose (CMC), and beechwoodxylan (XY), and the corresponding endoglucanase, xylanase, and β-glucosidase activities of the enzymes present in crude culture supernatants were determined. JB11 showed significant increase in endoglucanase activity (0.36 ± 0.04 U/mL) in PD, while JB10 endoglucanase activity was similar between the three media. Interestingly, xylanase activity of both isolates was relatively high (ranging 0.26-1.0 U/mL), with JB10 xylanase activity five-fold higher in PD. Lastly, there was 2-4-fold increase

detected in β-glucosidase activities (0.59-0.8 U/mL) in both isolates when grown in CMC or XY media. Phylogenetic analysis of the ITS sequences show that JB11 is *Aspergillustubingensis,* while JB10 is a novel *Fomitopsis*sp. isolate.(Christine JureneBacal and Eizadora, 2017)

Hemashekhar *et al.* (2017) reported the biological method of synthesis of silver nanoparticles by endophytic extracts isolated from the leaf of *Simaroubaglauca*. The surface Plasmon resonance characteristic of silver nanoparticles was revealed by the UV-Vis spectrum at 400 nm. The crystalline nature of silver nanoparticle was confirmed by X ray diffraction studies. Spherical shaped and monodispersed nanoparticles were found in Scanning electron micrograph. The average size of silver nanoparticles was 41.9 nm as determined by dynamic light scattering. The peak in silver region confirming the presence of elemental silver was determined by Energy dispersive X-ray spectroscopy analysis. Antibacterial activity of silver nanoparticles utilized in this study was found to be more significant than standard Taxim antibiotic against multidrug resistant bacteria such as *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus* and *Klebsiella pneumonia.* Endophytic based silver nanoparticles were found to possess significant antioxidant activity.
Silver nanoparticles (AgNPs) were synthesizedusing a reduction of aqueous Ag+ ion with the culture supernatants of*Aspergillusterreus*strain KC462061 isolated from the roots of date palm. The bio reduction of AgNPs was monitored by ultraviolet-visible spectroscopy.Thenanoparticles were characterized by UV–Vis spectrophotometry, Fourier transforminfrared spectroscopy (FTIR), X-ray diffraction (XRD), transmission electron microscopy(TEM) and scanning electron microscopy (SEM). These analyses revealed that the size ofnanospheres was about 17.5 nm on average and in the range of 5–30 nm the andpredominantly polydispersed and spherical. Moreover, the antimicrobial potential ofAgNPs was evaluated. AgNPsinhibited various bacteria and fungi.(Reena Rani *et al*.,2017)

One hundred and ninety-one fungal isolates were isolated from different mangrove sediments and preliminarily screened for their ability to produce protease based on the zone of clearance on skimmed milk agar plate. Among these isolates, ninety isolates were protease positive and produced a Relative Enzymatic index(REA) ranging from 1-2. On secondary screening in protease specific fermentation broth, five promising proteolytic fungi with enzyme activity above 35 U/ml were selected for further investigations. Based on the molecular characterization and phylogenetic studies, the selected isolates were identified as *Penicilliumgoetzii*TBG PayV, *Aspergillusaculeatus*TBG EkmII, *Penicilliumexpansum*TBG Ezh4, *Penicilliumoxalicum*TBG PayIV(b) and *Aspergillus flavus*TBG D2 Azk.(Reshma *et al.,* 2017)

Using morphological and molecular methods, *Arthrodermafulvum*was identified as the most effective fungal strain for synthesizing AgNPs. The UV–visible range showed a single peak at 420 nm, which corresponded to the surface plasmon absorbance of AgNPs. X-ray diffraction and transmission electron microscopy demonstrated that the biosynthesized AgNPs were crystalline in nature with an average diameter of 15.5±2.5 nm. Numerous factors could potentially affect the process of biosynthesis, and the main factors are discussed here. Optimization results showed that substrate concentration of 1.5 mM, alkaline pH, reaction temperature of 55°C, and reaction time of 10 hours were the optimum conditions for AgNP biosynthesis. Biosynthesized AgNPs showed considerable activity against the tested fungal strains, including *Candida* spp., *Aspergillus* spp., and *Fusarium* spp., especially *Candida* spp.(Xue *et al*., 2016)

The mangrove fungiwereisolated from mangrove habitat of Jharkhali, Sundarban, India. The physico-chemical properties liketemperature, pH, soil colour, moisture content, carbon and nitrogen content of soil determined the loadof microbial population. The soil sample was serially diluted and plated on potato dextrose agar platewith ampicillin to obtain fungal isolates. Total of six isolates were characterized microscopically bylacto phenol cotton blue staining. Two of them were identified as *Aspergillusniger*and *Penicillium*sp. and are subjected to biodegradation of fish scale, the major waste of fish processing industries.*Aspergillusniger*was found to be the best for degradation of fish scale powder by producing zone ofclearance. Moreover, media without fish scale didn't show any zone of clearance indicates themangrove fungi are capable of degrading the fish scale component. (VaswatiNandy *et al*., 2014)

The driftwood samples were collected from five different stations such as Chief corner, Koraiyar River, Saradi, Sethukuda, and Xavier Munai of Muthupet mangrove forest. A total number of23 fungal species coming under 11 genera were isolated from the drift woods. The common and dominant driftwood associated ten marine fungus were selected and grown in seven differentculture media. The fungus showed higher growth in SWPDA medium. Screening of extracellular enzyme production (amylase, protease, cellulase, pectinase and lipase) by the selecteddriftwoods associated fungi on was carried out by plate assay method. (ImmaculateJeyasanta *et al*., 2011)

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