2. REVIEW OF LITERATURE

Mangrove trees are fascinating study objects for the mycologist because the base of their trunks and aerating roots are permanently or intermittently submerged, whereas the upper parts of roots and trunks rarely or never reached by the salt water although they sometime may be subjected to saline spray. Thus, terrestrial fungi and lichens occupy the upper part of the trees and marine species occupy the lower part. At the interface there is an overlap between marine and terrestrial fungi (Kohlmeyer, 1969).

2.1. Obligate marine fungi

The early history of marine mycology starts with the report of Saccardo (1883). Ellis and Everhast (1885) who made a report on ***Ophiobolous*** sp. and of chytridiaceous from parasitic on algae (Peterson and Henning, 1905), which were active in the decomposition of living autotropic marine plant. In the successive years, Cotton (1907) and Sutherland (1915a,b,c, 1916) gave new additions to fungi occurring in marine environment.

The fungi from marine waters, intertidal soil and benthic sediments have been reported since 1930 and large number of papers describing the species have been published based on plating or dilution plate or baiting methods of isolation. These studies resulted in the isolation of several terrestrial fungi with a few marine or facultative marine species. Elliott (1930), by using dilution plate technique, isolated species of ubiquitous terrestrial fungi from the marshy soils of England and recorded lesser number of fungal propagules. Sparrow (1937) conducted a preliminary investigation of mycoflora of mud samples collected from Buzzard's Bay Gulf of Marine by using plating method and recorded many terrestrial forms.

The study of Barghoorn and Linder (1944), reported the fungi with remarkable adaptations for aquatic mode of life and the potential role of these fungi as wood degraders, which created much interest among mycologists. They carefully examined microbiological, chemical and physical factors involved in the decomposition and preservation of submerged plant materials from the sea and isolated several fungi specific to the marine environment.

The significance of pyrenomycetes as well as phycomycetes and fungi imperfecti in the biology and ecology of marine environment have been emphasized by various workers (Meyers, 1953, 1954; Hohnk, 1954; Ritchie, 1954). Various contemporary investigators have contributed to marine pyrenomycetes occurring in different areas of the world including Wales and Nothern Ireland (Wilson, 1951, 1954, 1956); Australia (Cribb and Cribb, 1955) Beaufort, North Carolina (Johnson, 1956a,b) and Coral Gables, Florida (Meyers, 1957).

Johnson and Sparrow (1961) in their monumental book "Fungi in Oceans and Estuaries" listed the fungi isolated from seawater and sediments. Fungi from marine sediments or soil were also isolated, which frequently included terrestrial species from this environment (Saito 1952, 1955; Park, 1972; Cowley, 1973). Further observations on higher fungi from seawater by using baiting techniques were also made by Hohnk (1959), Roth *et al.* (1964) and Mayers *et al.* (1967).

Neish (1970) studied 19 species of lignicolous marine fungi including 13 ascomycetes and 6 deuteromycetes from Nova Scotia. Among them, 17 species were new records for Nova Scotia. Kohlmeyer (1971) examined marine fungi from tropical and subtropical habitats and reported 18 ascomycetes, 8 deuteromycetes and 1 basidiomycete. Among them *Kymadiscus haliotrephus*, *Manglicola guatemalensis, Cytospora rhizosphorae* and *Rhabdospora avicenniae* were new reports.

Woody substrates often find their way into the sea. Besides, man deliberately introduces wood in the marine environment in the form of fishing crafts. Several ascomycetes and deuteromycetes produce a vast array of wood degrading enzymes. Kohlmeyer and Kohlmeyer (1979) reviewed the higher lignicolous fungi from wood and other cellulosic materials in their book, "Marine Mycology, the Higher Fungi."

Quantitative data on the occurrence of tropical marine fungi have been published by Raghukumar (1973), Koch (1982), Kohlmeyer (1984), Zainal and Jones (1984) and Vrijmoede *et al.* (1986). However, all these reports were on driftwood in the sea, along with driftwood on the mangrove floor or panels belonged to various timbers submerged near jetties.

Booth (1979) reviewed the reports on the marine fungi in Brazillian and South American waters. Various ecological consideration of substrate, habitats and individual fungal species were made in relation to different lignicolous (50), folicolous (21), rhizosphere (10) and algicolous (17), chytrids and thraustochytrids (18) and nematode trapping fungi (2). Rees *et al.* (1979) studied lignicolous marine fungi colonized the driftwood collected in Danish Sand dunes.

Krylova (1980) studied the higher marine fungi from coastal areas of the Sea of Japan. Totally 12 species of fungi (9 ascomycetes and 3 deuteromycetes) were recorded. Thirty seven higher marine fungi belonged to 27 species were recorded from woods collected in the lower Chesapeake Bay area. The total number and frequency of the taxa were more in winter than in other seasons (Kirk and Brandt, 1980). Kohlmeyer (1980) studied the distribution of higher filamentous fungi in tropical and subtropical parts of the Western Atlantic Ocean. Totally 54 species with 34 ascomycetes, 18 deuteromycetes and 2 basidiomycetes were recorded.

Kohlmeyer (1981) investigated the filamentous higher marine fungi from different substrates such as leaves and rhizomes of *Thalassia testudinum,* pneumatophores of *Avicennia germinans*, prop roots of *Rhizophora mangle*, roots of *Hibiscus tiliaceus* and intertidal and subtidal wood samples of unidentified hosts collected from Island of Martinique (French Antilles) and recorded 20 species, and among them 18 species were new records for this Island. Miller and Whitney (1981) examined the driftwood, intertidal wood and submerged panels from the new Brunswick coast of Bay of Fundy and recorded 34 species of fungi. Among them 5 were the first reports in that study area.

Vrijmoed *et al.* (1982) investigated the seasonal pattern of primary colonization of marine fungi over the pine block submerged in the coastal waters in Hong Kong. Thirty eight species of fungi were isolated, three of which were not identified. Among them five species (*Periconia prolifica*, *Cirrenalia macrocephala*, *Ceriosporopsis halima*, *Trichocladium achrasporium* and *Halosphaeria quadricornata*) were the most frequent and most abundant fungi on the blocks recovered at monthly intervals. Lintott and Lintott (1982) examined the driftwood collected from the East coast of New Zealand and recorded twenty species of wood inhabiting marine fungi.

Both (1983) studied the lignicolous marine fungi on the wood and leaves collected from Sao Paulo and Pernambuco States. He isolated 32 species which included 24 ascomycetes, 1 basidiomycetes and 7 fungi imperfecti.

Tokura (1984) reported 18 species of sand inhabiting fungi from the sand collected beneath the driftwood. The most frequently observed species were *Corollospora maritima*, *Arenariomyses trifurcates*, *Carbosphaeralla leptosphaerioides*, *Lulworthia* sp. and on unidentified species.

Maharashtra coast (West coast) was extensively surveyed for marine fungi (Patil and Borse, 1985; Borse, 1984, 1985, 1987, 1988; Borse *et al.,* 1988; Borse and Hyde, 1989). Vanzanella *et al.* (1985) carried out a preliminary investigation on the mycoflora of Lake Fusaro, Italy. Totally 19 marine fungi were recorded including 12 ascomycetes, 1 basidiomycetes and 6 fungi imperfecti. Forty four marine fungi were recorded from driftwood which included 2 basidiomycetes, 6 deuteromycetes and 36 ascomycetes from San Juan Island (Jones, 1985).

Kohlmeyer and Kohlmeyer (1987) studied the higher marine fungi from the wood which were collected from Aldabra (8 species), Galapagos (10 species), Hawaii (17 species) and Tabago (22 species). Shearger and Burgos (1987) reported fungi occurring on intertidal wood collected from 16 sites from Arica Punta Arenas in Chile. Thirty three ascomycetes (6 unidentified forms), 1 basidiomycetes and 8 fungi imperfecti were recorded from the wood.

Hyde and Jones (1989) studied the marine fungi on submerged wood, wood trapped amongst rocks, sand-buried wood and exposed roots and branches of shoreline trees and also recorded four filamentous marine fungi on leaves, seaweeds and sea grasses washed up on the seashore and sea foam collected from three intertidal beach sites in the Seychelles.

Kohlmeyer and Kohlmeyer (1989a) studied the marine higher fungi in Belize (Central America) and isolated 46 taxa belonged to 37 species of ascomycetes, 2 basidiomycetes and 7 deuteromycetes.

The occurrence and distribution of lignicolous marine fungi in the Straits Messina were studied by Grasso *et al.* (1990) by using submerged panels of pine and isolated 20 species of fungi. Kohlmeyer and Kohlmeyer (1991) isolated from the wood collected from the sandy beaches and the mangal of Queensland and reported 28 species as new record for Australia. They reported 43 species of ascomycetes, 1 basidiomycetes and 5 imperfecti fungi.

Chinnaraj and Untawale (1992) reported marine mangrove fungi from Lakshadweep islands and other areas on the West coast. Kohlmeyer and Kohlmeyer (1993) studied the biogeographic observations on pacific marine fungi. A composition of the marine mycota of recently introduced *Rhizophora* species (Hawaii and Moorea) with that of long established *Rhizophora* stands in the Caribbean (Belize) revealed interesting differences. Only 7 and 21 species were recorded from Moorea and Oahu respectively, while 43 species were recorded in Belize.

Kohlmeyer *et al.* (1995) reported 4 new marine ascomycetes namely, *Halosarpheia culmiperda*, *Massarina ricifera*, *Ommatomyces coronatus* and *Gaeumannomyces medullaris* from *Juncus roemmyces. Phomotospora nypae*, a new marine fungus, was also described from the leaves of *Nypa fraticans* submerged in the intertidal region of Malaysia.

Raghukumar (1996) studied the lignicolous marine fungi of Madras coast of India during 1967-1971. He recorded 12 Ascomycetes and 6 fungi imperfecti from driftwood and wood submerged in the sea. Sundari *et al.* (1996) reported 17 species of fungi growing on buried wood collected from Singapore. The most frequent species were *Periconia prolifica, Savoryella appendiculata, Corollospora pulchella* and *Trichocladium alopallonella.*

Peterson and Koch (1997) reported 46 lignicolous marine species including 34 ascomycetes, 11 deuteromycetes and 1 basidiomycetes in Svanemollen Harbour, Denmark.

New marine fungi such as *Anthosotomalla torosa, A. spissiteeta, Octopodotus stupendous* and *Phyllachora paluclicola* were also reported by Kohlmeyer and Kohlmeyer (2003, 2004). Frayer and his coworkers

Maharashtra. Further, he also reported that some rare ascomyceteous fungi as new record for India. *Cirrenalia tropicalis* was isolated and reported from Vellar estuary, East coast of India (Ravikumar and Purusothaman, 1988a). Ravikumar and Purusothaman (1988b) discovered *Corollospora intermedia,* a new record of lignicolous marine fungus from Vellar estuary, Tamil Nadu, India.

Sridhar and Kaveriappa (1991) studied marine fungi on sand and foam samples from Mangalore coast, Karnataka. Five ascomycetes and 4 deuteromycetes were encountered. Among them *Arenariomycis trifuscatus* and *Clavariopsis bulbosa* were frequent. Four species of ascomycetes were reported from the driftwood collected from Mangalore coast, India (Sridhar and Prasannarai, 1993). Among them three species namely *Corollospora filiformis*, *Halosarphelia viscosa* and *Trematosphaeria mangrovei* were reported for the first time in India. Shrivastava (1994, 1995) studied the marine fungi in different localities of Bombay coast.

Santhakumar *et al.* (1994) studied the colonization of lignicolous marine fungi over the panels of different timbers submerged in the marine water along Goa coast and 14 species of marine fungi were recorded. Among them, *Halosphaeria quadricornuta* and *Periconia prolifica* were the abundant species in the wood recovered from the sea.

The lignicolous marine fungi of Madras coast were studied in India during 1967-1971 by Raghukumar (1996). He recorded 12 ascomycetes and 6 fungi imperfecti from submerged driftwood collected from sea. Prasannarai and Sridhar (1997) also studied the lignicolous marine fungi on the driftwood samples and recorded 16 ascomycetes, 2 basidiomycetes and 6 deuteromycetes. The fungal endophytes occurring in four halophytic trees were screened by Suryanarayana and Kumaresan (2000). Thirty six species of fungi, including some sterile forms were isolated. *Camarosporium* species was the dominant endophyte of the halophytes belonged to *Chenopodiaceae*.

Prasannarai and Sridhar (2001) studied the diversity of marine fungi on wood samples collected from intertidal regions in the West coast of India. Altogether 88 species belonged to 65 ascomycetes, 3 basidiomycetes and 20 deuteromycetes were recorded.

Sarma and Vittal (2001) studied the decaying plant samples collected from mangrove in Godavari and Krishna deltas (Andhra Pradesh), East coast of India. Totally 88 species were identified, which included 65 ascomycetes, 1 basidiomycetes and 24 mitosporic fungi.

Vishwakaran *et al.* (2001) studied the spatial and temporal distribution of fungi in the coastal tropical waters of Goa. They recorded 33 species of fungi and among them 20 belonged to ascomycetes, 1 basidiomycetes and 12 deuteromycetes.

The occurrence and distribution of endophytic fungi in Pichavaram mangrove forest, Tamil Nadu and Udayavara mangrove forest Karanataka were also studied (Ananda and Sridhar, 2002; Kumaresan and Suryanarayanan, 2000; Kumaresan *et al.*, 2002).

Fungal assemblage, richness and diversity were assessed on woody substrates sampled periodically from three intertidal habitats of South West coast of India for two successive years (Prasannarai and Sridhar, 2003). Among 41 fungi recorded, 30 species belonged to ascomycetes, 2 basidiomycetes and 9 deuteromycetes.

In the South West coast of India, Ananda and Sridhar (2004) studied the diversity of filamentous fungi on decomposing leaf and woody litter of mangrove forests, Nethravathi and Udayavara. Altogether 78 fungal taxa were recovered from leaf and woody litters. Samples collected during summer showed maximum fungi (65 taxa) than those collected during monsoon (55 taxa). Maria and Sridhar (2004) also studied the fungal colonization of immersed wood from these mangrove environments. They also reported 36 species of fungi and among them, *Lulworthia* sp. was the most common fungus (44.9%) followed by *Tirispora* sp. (30%). Kumaran and coworkers (2004) reported 8 species of fossil marine manglicolous fungi from Malvan (Konkan), West coast of India.

Thirty nine species of fungi were identified from decayed wood of *Avicennia marina*. Among them 19 were new records for the Egyptian Red Sea mangroves. The most frequent fungi was *Swampomyces armeniaceous*. Other common fungi included: *Hypoxylon* sp., *lineolata* sp., *Kallichroma tethys*, *Swampomyces aegyptians* and *Lulworthia grandispora* (Abdel-Wahab, 2005).

The occurrence of marine fungi associated with pieces of wood, driftwood and dead plant stems, in the intertidal zone of two sandy beaches on the Portuguese west coast was reported by Figueira and Barata (2007). They found that out of 90 samples scanned, 90 per cent had sporulating marine fungi. Thirty-five marine fungal taxa were identified (27 Ascomycota, 6 anamorphic fungi and 2 unidentified taxa) out of which 11 species were common to both beaches. Most taxa were infrequent (<10%), with the exception of *Krischteiniothelia maritima* (10 to 20%). The average number of fungi per sample was 0.91 for both beaches.

Liu *et al.* (2007) isolated more than 200 species of endophytic fungi from mangrove, being the second largest community of microfungi. The reported endophytic fungi of mangrove included *Alternaria, Aspergillus, Cladosporium, Collitrotrichum, Fusarium, Penicillium, Phoma* and *Trichoderma*. Most of the endophytic fungi have wide range of hosts and a few only preferred single hosts. However, the composition and dominant species on each mangrove are different.

2.2. Facultative marine fungi

The work on fungi in mangrove swamps was initiated by Cribb and Cribb (1955, 1956), who found some new ascomycetes in Australia. Swart (1958) investigated the horizontal distribution of fungi around two mangrove swamps in the islands of Inhaca (East Africa). He obtained positive correlation between the amount of carbon and the variety of the fungal flora. He also found that the phycomycetes were almost absent, ascomycetes were rare, except *Aspergillus* and *Penicillium*, and basidiomycetes were entirely absent. Pugh (1961) reported that the fungi in marine mud were numerous as in normal soil. He further reported that there was overall upshore increase in the number of fungi isolated per unit of sample which may reflect the increased amount of organic matter and reduced periods of inundation by the sea at higher levels. Johnson and Sparrow (1961) in their monumental book 'Fungi in Oceans and Estuaries' listed the fungi isolated from seawater and sediments.

Swart (1958, 1963) examined the culturable mycoflora of mangrove soil of Eastern Africa and reported *Cladosporium, Alternaria, Aspergillus, Penicillium, Phoma, Septonema, Robillardo* and *Periconia* from mangrove soils. He observed the absence of basidiomycetes and the rare occurrence of ascomycetes and phycomycetes.

Pawar and Thirumalachar (1966) stated that the number of fungi proportionately increased with the rise in the organic matter level. They have also suggested that the present marine species might have been migrated from terrestrial habitat and got adapted to saline conditions. Ulken (1970, 1972, 1975, 1977, 1978 and 1984) studied the halosporic lower fungi in the sediments of Mexico.

Swart (1970) reported a new *Penicillium* species from Australian mangrove soil. Lee and Baker (1972a, b, 1973) investigated soil microfungi from rhizoplane and rhizosphere of *Rhizophora mangle* in Hawaiian mangrove swamps by using plating techniques.

Subramanian and Raghukumar (1974) investigated the mycoflora of certain estuarine intertidal beach and saline soils. They found wide variety of fungal species in the estuarine soils. The average number of fungal propagules was low in marine soils when compared to that of normal virgin or cultivated non saline soils.

Upadhyay *et al.* (1978) studied the ecology of microfungi in a coastal sand belt near Kanyakumari (Cape Comarine) with special reference to soil microenvironment. Aspergilli and Penicillia were the most common components of beach and sand dunes. D'souza and Araujo (1979) and Araujo *et al.* (1981) have studied the fungi from mud and sediment samples of Bandara in Bombay and Chapora, Panaji and Agasim in Goa, West coast of India and reported the predominance of *Chaetomium globosum*, *Aspergillus nidulans*, *Rhizopus* sp. and *Curvularia* sp.

Chowdhery (1979) described 5 species of aquatic Oomycetes which were new records from Indian mangroves. Matondkar *et al.* (1980a, b) studied the seasonal variations of mycoflora from mangrove swamps of Goa and for various exoenzyme activities.

Chowdhery (1979) investigated the rhizosphere, rhizosplane and non-rhizosphere soil fungi in Sunderban mangroves, West Bengal. Highest number of fungi was isolated from rhizosphere zone. Ascomycetes were frequent in rhizosplane and zygomycetes in rhizosphere, whereas basidiomycetes were absent. They observed the active growth of many terrestrial species in mangrove swamps by direct microscopic method.

Chowdhery (1983a, b) studied the ecological specialization (osmotic tolerance, salinity and temperature relationship) of some mangrove swamp fungi from Kagh Islands, West Bengal. All the 78 isolated species grew well at temperature, 25, 30, 35 and 40°C. Salinity 6 ppt, osmophilic ranges from 9 to 60 per cent of sodium chloride and sucrose respectively. Garg (1983) investigated the vertical distribution of fungi in Sunderban mangrove. Among the 223 species of fungi isolated from different depth of mangrove mud, 64 species were recorded for the first time. He recorded the highest number of fungi from surface layer and the number and frequency decreased with increasing soil depth.

Prabhakaran *et al.* (1987) studied the species composition and microbial activities in the Mangalvan estuarine mangrove ecosystem. Thirty one fungal isolates were recorded from the soil and 27 from decaying leaves, stem and roots of the mangrove macrophytes. *Aspergillus* was the dominant fungal genus followed by *Penicillium, Fusarium* and *Trichoderma.*

Tannin content of mangrove leaves was studied in relation to phylloplane fungi by Sivakumar and Kathiresan (1990). They found negative correlation ($r = 0.95$) between the two for all the seven mangrove species. *Rhizophora* species with high tannin content showed less number of fungal colonies/cm^2 leaf area and it was vice versa with *Avicennia* sp.

Raman and Chandrika (1993) studied the rhizosphere mycoflora of *Acanthus ilicifolius* from Murukkampadam area in Vypeen Island and near Cochin Backwater in front of Central Marine Fisheries Research Institute (CMFRI). The fungi isolated from the soil were mostly belonged to species of *Fusarium*, *Penicillium*, *Aspergillus* and *Rhizopus*.

2.3. Enzyme production

Fungi play an important role in the degradation and mineralization of lignocellulosic substrates in the marine environment. The importance of lignicolous fungi occurring in wood submerged in the sea was reported by Barghoorn and Linder (1944). The degradation of such substrates takes place through the secretion of corresponding enzymes by the marine fungi.

The degradation process of marine fungi involving the production of intra and extra cellular enzymes have received considerable attention globally. The cellulolytic activity of lignicolous marine fungi (both ascomycetes and deuteromycetes) has been demonstrated in detail (Meyers and Reynolds, 1959a, b, 1960, 1963; Meyers and Scott, 1968; Meyers *et al.* 1960). Jones and Irvine (1972) discussed the degradative role of filamentous marine fungi in the marine environment.

Pisano and Mihalik (1964) screened 14 marine fungi for the gelatinase activity, in which 13 isolates showed the gelatinase activity. The enzyme system in several marine fungi was examined by Sguros *et al.* (1970). Desai and Betrabet (1971) studied the cellulolytic activity of fungal isolates from Bombay waters.

Nilsson (1974) employed several methods to assay the enzymatic activities of 36 lignicolous fungi. He found that marine fungus, *Humicola alopallonella* was unable to degrade pure cellulose substrate in culture but produced characteristic soft-root patterns.

Eaton (1986) demonstrated the degradation ability of cell wall components by several marine fungi belonging to the genera, *Cirrenalia, Halosphaeria, Humicola, Niacalcitalna* and *Zalerion.* The results were compared with freshwater and terrestrial fungi. Production of cellulase and xylanase by all these fungi were also tested. Nair *et al.* (1977) studied the distribution and activity of L-asparaginase producing fungi in the marine environment of Porto Novo, East Coast of India.

D'souza (1983) screened the pectinolytic fungi from the mangrove swamps of Chapora, Mandovi Sal and Zuari estuaries of Goa. Nearly 73 per cent of the isolates exhibited pectinolytic activity. Gomes and Mavinkurve (1982) investigated phenolic compounds degrading yeast from Mandovi-Zauri estuarine.

A major requirement for the production of these lignin degrading enzymes by most of the white rot fungi is oxygen-saturated culture conditions and therefore extremely shallow cultures are most suitable for this purpose. The direct evidence of lignin-degradation by white-rot fungi is provided by mineralization of ^{14}C labelled lignin to $^{14}CO_2$ have been reported by Freer and Detroy (1982).

Molitoris and Schaumann (1986) and Schaumann *et al.* (1986) reported a detailed information on the extracellular enzyme production by marine fungi (ascomycetes, basidiomycetes and deuteromycetes).

Laccases are copper-containing glycoproteins and have been implicated in lignin degradation because they are capable of oxidizing and depolymerizing different lignin model components. They bring about solubilization of lignin from lignocellulose without the presence of any peroxidase (Galliano *et al.*, 1988). The catalytic oxygen-dependent oxidation of phenolic compounds are found in both plants and fungi. Both inducible and constitutive laccases have been reported from fungi. The current evidence indicates that this enzyme is part of the lignolytic system of some of the most efficient and selective lignin degraders (Roy-Arcand and Archibald, 1991; Ruttiman *et al.,* 1992).

The laccase and other lignocellulose modifying enzymes of marine fungi, isolated from the coast of India, were assessed (Raghukumar *et al.*, 1994). The potentiality of the marine fungi to degrade alginate was studied by viscometric method by Moen *et al.* (1994).

Chitinase, an important enzyme which degrade fungal cell wall, production and the chitinolytic activity of marine fungi such as *Corollospora maritima* and *Lindra obuta* have been investigated (Grant *et al.*, 1996). Kumaresan *et al.* (2002) have investigated the fungal endophytic association of mangrove host in Southern India and reported the production of extra cellular enzyme.

Kathiresan (2003) studied polythene and plastic degrading microbes in Indian mangrove soil. Among the 8 species of the fungi, *Aspergillus glaucus* degraded 28.80 per cent of polythene and 7.26 per cent of plastics in one month period.

Verma *et al.* (2004) investigated the production of endoxylanase by a marine isolate of *Aspergillus niger*. The influence of pH, salinity, nutrients and incubation temperature of the medium on the production of microbial enzymes has been demonstrated with marine fungi by Cherry *et al.* (2004) and Feeney *et al.* (1992). Such kinds of studies were also made for certain soil (terrestrial) and plant pathogenic fungi (Mandels and Reese, 1957; Rangaswami and Chandrasekaran, 1963; Raman, 1978; Madan and Sood, 1980; Rajamani and Hilda, 1987;, Panneerselvam and Saravanamuthu, 1999).

Kothari *et al.* (2005) studied lignolytic enzymes of *Coriolopsis polyzona* which were able to degrade supra Blue H3RP, yellow H4G2 and violet 3R dyes. Lignolytic enzymes such as manganese peroxidase (MnP) and laccase produced by this fungus were tested under different physico-chemical conditions.

Kathiresan and Manivannan (2006) studied the effect of pH, temperature, incubation time, salinity, source of carbon and nitrogen in submerged fermentation process for production of α-amylase by *Penicillium fellutanum* . isolated from coastal mangrove soil. The production medium without addition of seawater and with provision of maltose as carbon source, peptone as nitrogen source, incubated for 96 h, maintained with pH of 6.5 at 30°C was found optimum for the production of α amylase by *P. fellutanum*.

Niranjane *et al.* (2007) evaluated the influence of different carbohydrates including glucose, xylose, carboxymethyl cellulose (CMC), microcrystalline cellulose (aviul) and cellobiose as carbon sources for the production of cellulase by the saprophytic fungus *Phlebia gigantea*. Carboxymethyl cellulose gave the highest yield, followed by cellobiose and aviul. *P. gigantea* did not produce any detectable cellulases in the presence of glucose and xylose which suggest the repression of cellulase. These results showed that the production of cellulase not only depends on the pH but also on the consumption of carbon sources in medium.