INTRODUCTION

Man has been interested in trees since time immemorial, but trees on streets as avenue trees, parks, or forests have increased considerably in last 20 years or so. Since ancient times, mankind is preserving some trees symbolically as if they are deemed to be adobe of deities and spirits. From the earliest time to till date, legal regulations have been framed to protect trees for reasons of taboos, aesthetic perceptions and competing forms of utilization, influenced by constantly changing concepts of value. A new consensus has been emerged in the last two decades which considers it sensible to protect trees in urban situations simply for environmental reasons. One reason for this has been the decline and dying of forests which caused great concern about our environment from 1980s to till date. Due to the prominence of this event, which is blamed on abiotic factors, it is all too easy to forget that life of trees is also affected by multitude of biotic factors such as: viruses, bacteria, fungi and animals. These may have very different relationships with trees, but are usually deleterious. Among these, fungi are the most common biotic factors that affect the trees.

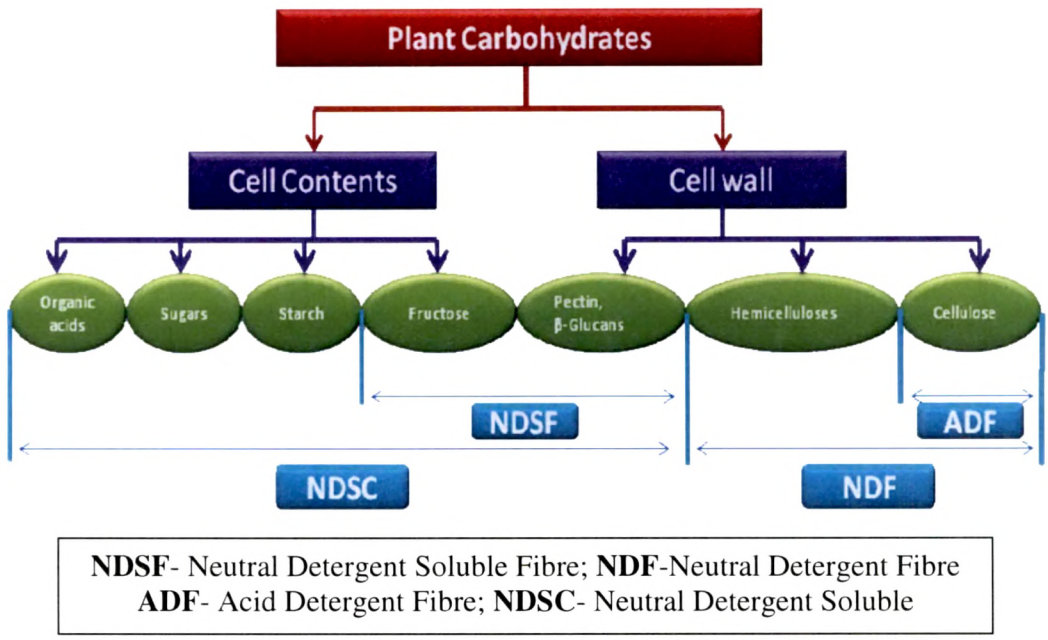
Fungi that inhabit the forest floor are the most important agents in recycling the carbon stored in wood. Among them, white rot Basidiomycetes especially play a pivotal role in the forest ecosystem since they are the only fungi capable of degrading all cell wall components of wood (Zabel and Morrell, 1992; Connolly and Jellison, 1997; Maloy and Murray, 2001). On the other hand, they also play fundamental role in the large economic losses of timber and forest products by decay and deterioration (Boddy and Watkinson, 1995). Tree decay is the major worldwide cause that damages the trees. Decay causes more damage to the timber than all other destructive agents combined. From 20-80% of the world timber is lost annually, or used for low-quality products because of decay (Zabel and Morrell, 1992; Connolly and Jellison, 1997; Maloy and Murray, 2001).

During the course of evolution wood rot fungi have developed various abilities and strategies in order to obtain nutrients. On the other hand, trees have also learned to react for external and internal infections. In wood decay, structure of wood as well as enzymatic potential of fungi plays an important role. Almost all the trees differ in anatomical as well as structural features with respect to cell wall composition (Figure 1) and wall layers (Eriksson, 1990). The extent to which a pathogen can invade a substrate and the method it uses to do, will depend both on its ability to degrade different cell types and cell wall constituents. It also depends on its adaptability to the other conditions of the host.

Structure of wood:

Wood is made of mainly three polymeric constituents. It contains about 45% cellulose, 20-30% hemicelluloses and 25-30% lignin (Higuchi, 1997). The main structural component of wood cell is the cellulose whereas; hemicelluloses are heteropolysaccharides. Like cellulose, the most hemicelluloses function as supporting materials in the cell walls and relatively they are easily hydrolysed by acids (Mohebby, 2003). Lignin as the binding agent holds the cellulose together

whereas; cellulose is more stable than lignin. Lignin however, fills the space in the cell wall among cellulose, hemicellulose and pectin components. It is the biopolymer and is indigestible by mammalian and other animal enzymes, but some fungi and bacteria are able to biodegrade this biopolymer. Hemicellulose contains many different sugar monomers.



NDSF- Neutral Detergent Soluble Fibre; **NDF**-Neutral Detergent Fibre
ADF- Acid Detergent Fibre; **NDSC**- Neutral Detergent Soluble

Figure 1: Plant carbohydrates and its' components.

Kerr and Bailey (1934) have given five cell wall layers scheme and are usually taken as starting point for structure of the lignified cell wall. Five layers include middle lamella, primary wall and three layers of secondary wall (Figure 2).

Starting with middle lamella, it is a cementing layer between the walls of adjacent cells, and also called as connector because it performs important task of connecting the neighbouring cells to one another (Liese, 1981; Wagenfuhr, 1989). Pectin is the main constituent of middle lamella; it is a polymeric substance with carboxyl groups partially esterified by methanol. The thickness of middle lamella ranges from a few tenths of a micrometer upto 5 μm in the cell walls. Mechanical

properties of middle lamella are to impart strength and stiffness to the cell walls (Brooker, 1996).

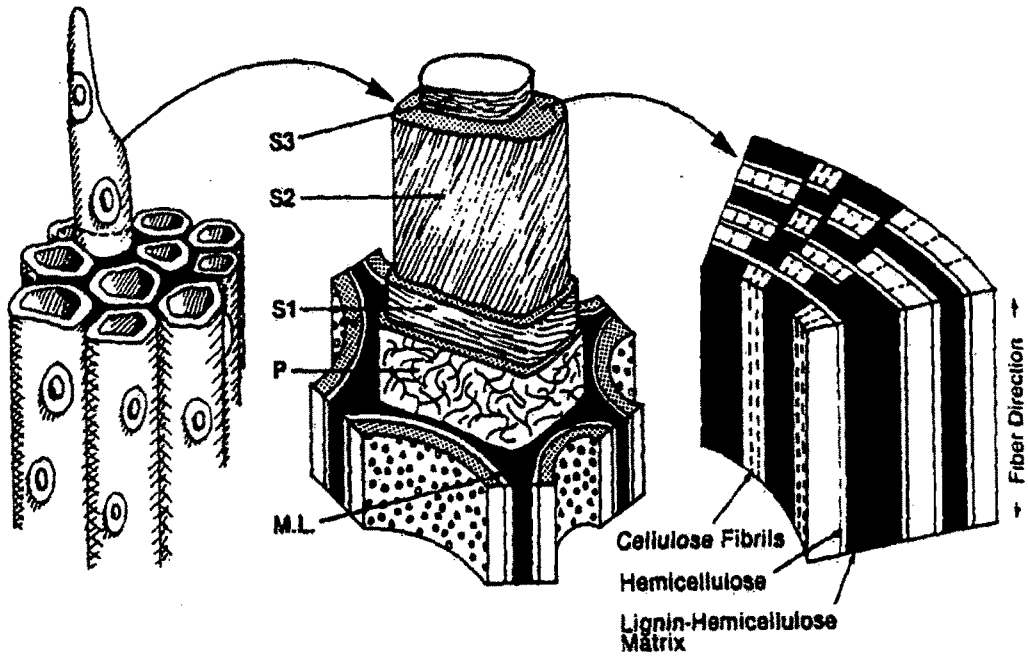


Figure 2: Schematic diagram of structure of wood.

Cell wall:

Primary cell wall is difficult to distinguish from the adjacent middle lamella and is evaluated jointly with middle lamella from the biomechanical point of view. The primary cell wall exhibits a framework substance of cellulose microfibrils, besides the matrix. This cell wall layer is characterized by its cellulose forming only 2.5% of the total chemical constituent whereas; microfibrils are scattered and found mainly transversely to the axis of the cell (Schwarze *et al.*, 2000). The secondary wall forms the largest part of the cell wall. Cellulose forms 94% of chemical constituent of secondary wall and mainly functions to impart high tensile strength to the cell. From middle lamella towards cell lumen side, cell walls have been further bifurcated into three layers: outer (S_1), middle (S_2), and an inner (S_3) layer of secondary wall.

Next to the primary wall is the outer secondary wall (S_1 layer). Main constituent of secondary wall is cellulose microfibrils which show weak parallel arrangement and oriented transversely to longitudinal axis of the cell with few micrometers (0.2 μm approx.) in thickness.

Next to S_1 is central secondary wall (S_2 layer) which is relatively thick and forms the bulk of the cell wall. In this part of the cell wall, cellulose microfibrils are arranged parallel to each other as shallow spirals (parallel helical arrangement) nearly in the direction of longitudinal axis of the cells. Cellulose, lignin and hemicellulose following one another, together form the S_2 layer. The high content of cellulose in S_2 layer clearly indicates that great part of tensile strength is imparted by S_2 layer. Since the S_2 layer is rich in carbohydrate content, it is preferentially broken down by most of the fungi. This has been consequence that even small amount of degradation at the initial stage will lead to a drastic reduction in wood strength (Wilcox, 1978; Schwarze, 1995).

The inner most secondary wall (S_3 layer) seperates off the cell wall from the lumen. It is relatively thin and consists only of a single lamella. Microfibrils are arranged in the tertiary wall either parallel or slightly scattered with texture resembling the primary wall. On the basis of its chemical composition, S_3 layer certainly occupies special position within secondary wall. In angiosperms, it has much less cellulose than the S_2 layer whereas; in conifers it clearly exhibits a high degree of lignifications (Brooker and Sell, 1998). Therefore, these cell wall layers i.e. outer (S_1) to the inner most secondary wall (S_3) play important role and increase resistance to degradation by the fungi (Schwarze and Engels, 1998). Thus, the structural difference of the secondary walls in different cell elements has a significant influence on wood decay and resistance to pathogen.

Wood Decay:

Wood which is mainly used in manufacturing of products starts decaying with the attack of microorganisms, called as Biodegradation. It can be defined as change in the properties of nonliving material caused by activities of living organisms (Zabel and Morrel, 1992). Biodegradation is supposed to be one of the major challenges to incur the heavy economic losses. More than 80% of trees are lost annually, or used for low quality products because of decay (Zabel and Morrel, 1992). Fungi and stem boring insects are the major causes of biodegradation. Therefore, wood products are subjected to various bio-hazard attacks if proper preventive measures are not taken.

In process of wood decay, tree wounds are the first step in a microbial attack that may lead to discoloration and ultimately to decay of tree trunks, roots and limbs. Broken branches, pruning stubs and mechanical injuries to roots, trunk or branches are the types of wounds most commonly associated with decay problems. In urban areas, one of the most frequent causes of damage to trees in the landscape comes from lawn equipment (Shigo, 1979). Movers and string trimmers can damage the bark at the base of the trunk. Initially, there may be no visible evidence of injury, although the injured plant will lack vigour. Continued injury will result in visible wounds at the base of the trunk, besides that it restricts the movement of food, water and mineral elements. These wounds become excellent points of entry for insects and wood decay fungi (Schwarze *et al.*, 2000).

When an injury or break in the bark exposes the underlying wood to bacterial and fungal spores present in the air, they infect the wound surface. At the same time, the tree responds to the wound by producing chemical and physical barriers in an attempt to block the invasion of microorganisms and to seal off the damaged area (Shigo, 1984). Organisms which are able to overcome these protective barriers can then colonize and invade the wounded tissues. Once these

microorganisms have established themselves in these wounds, initiation of wood deterioration starts with secretion of extracellular enzymes. Among these organisms, the most common are the wood decay fungi. There are varieties of wood decay fungi which have the ability to digest wood cell wall thus, causing it to rot. Presence of mushrooms at the base of the tree, or conks (bracket, shelf-like fungal structures) on trunk or branches, are the most certain and common indicators of decay. Absence of these fungal structures (also referred as "fruiting bodies") obviously does not mean that the tree is free of decay. Fruiting bodies of some decay fungi do not appear until decay is well advanced while others may go unnoticed because they are small; short lived, hidden or produced infrequently. Other indicators of decay include old wounds, hollowed out areas, and abnormal swellings or bulging of stems and branches. Decayed wood is usually soft, white, spongy, stringy and friable or brown and brittle. Since decay structurally weakens the wood, affected trees become susceptible to wind or other storm damages. Different fungi have different modes of action for penetrating into the wood to get nutrients thus, ultimately causing loss of wood. In order to understand wood decay, it is important to understand first the major modes of decay by fungal pathogens.

Factors affecting wood decay:

Though, several species of fungal spores are common in the air, they cannot directly develop and attack unless they get favourable conditions as follows:

- An adequate supply of oxygen.
- A favourable temperature (15 °C – 40 °C).
- Moisture in excess of fibre saturation point (25-30%).
- A suitable source of energy and nutrients (i.e. the wood).
- Absence of antagonistic influence of other fungi.

Optimum temperature required for growth varies with different species of wood decay fungi. According to Mohebby (2003), decay fungi require a specific level of moisture content for propogation and in absence of lumen water fungal growth is greatly retarded. Moisture content of wood below 20% completely inhibits the growth and development of the fungus. It requires the free water (lumen water) whereas, sap stain fungi can grow even with bonded water.

When the climatic conditions are favourable for spore germination, many different species of wood inhabiting fungi may establish and start growing. Beside moisture content, growth and decay largely depends on durability of wood and the type of decay fungi. Therefore, heartwood with higher natural durability would be expected to make much resistance and takes longer time for fungal establishment.

Terms for position of decay:

Pattern of wood decay differs in both living and dead trees. In general, living trees tends to decay from the inside out i.e. from centre towards periphery, while in dead trees it occurs from the outside in. It is largely due to the fact that sapwood has a very effective and active resistance owing to the presence of parenchyma cells when the tree is alive, but virtually there is no resistance in sapwood once the tree is dead (Boddy and Rayner, 1983; Koyani *et al.*, 2010, 2011).

On the basis of decay position, wood decay fungi are generally classified into two main types: i) heart rot fungi and ii) sap rot or soft rot fungi (Figure 3). Heart rot is often defined as decay that develops primarily in the heartwood or inner wood of living trees (Gibson, 1981). However, the term heart rot is usually used to refer a type of decay that primarily develops in the stem rather than in the root and butt whereas; sap rot is referred to decay that develops in the sapwood. As mentioned earlier that sapwood has the highest resistance in living trees but it

decays extensively when the tree is dead, but in case of parasitic fungi decay mostly starts in sapwood of living trees and they usually cause cankers.

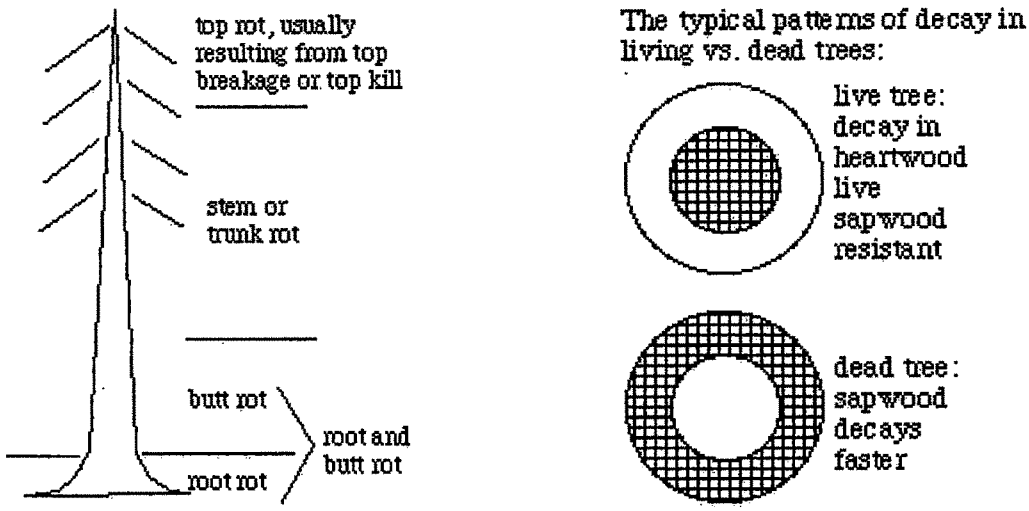


Figure 3: Terms for position of decay by fungi.

In all the decay types, it is very common that once decay has started in wood, the rate and extent of deterioration depends on the duration of favourable conditions for fungal growth. Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is lower than the requirements of the fungi. Decay can resume when the temperature and moisture content become favourable again. Early decay is more easily noted on freshly exposed surfaces of unseasoned wood than the seasoned wood that has been exposed and discolored by the weather (Randall, 1999).

Fungi:

Wood rot fungi are microorganisms which live on and within wood with slowly digesting the cell wall materials and obtain nourishment by digesting the cell walls thus, leading to softening and deterioration of wood. Wood decay generally occurs in untreated wood that is directly in contact with ground, cement, concrete or

exposed to a source of moisture such as rain, seepage, plumbing leaks or condensations.

Most wood decay fungi belong to the class Basidiomycetes and Ascomycetes. Basidiomycetes form spores on narrow gills or on the underside of fruiting bodies. On the other hand, fungi from the class Ascomycetes produce their spores in the sacs (Alexopoulos and Mims, 1996). Wood decay fungi invade trees either by landing of spores on wounds, or by root to root contact. After the germination of spores, thread like strands of the fungal body called hyphae colonizes the heartwood. When the wood is well colonized; the fungus forms fruiting bodies (conks, mushrooms) that produce more number of spores (Shigo, 1979).

Wood decomposition by fungi is usually seperated into three categories depending on the pattern of wood decay. Changes induced in response to fungal attack on wood may be micromorphological alterations, chemical alterations or changes in the physical properties of the wood. Acoording to different patterns of attack on the middle lamella, S_1, S_2 and S_3 layers, wood decay fungi are divided into: (1) brown rot (2) white rot, which is further subdivided into simultaneous rot and selective delignification, and (3) soft rot (Liese, 1970; Schwarze and Fink, 1998; Lehnringer *et al.*, 2010).

Brown Rot:

The hyphae of brown rot fungi grow within the cell lumina on the surface of the S_3 layer but cause little alteration in this layer or to the middle lamella. However, S_2 and S_1 layers become extensively degraded due to the removal of cellulose components of wood as energy source, leaving a brown residue of lignin (Liese, 1970; Rayner and Boddy, 1988; Eriksson *et al.*, 1990; Schwarze and Fink, 1998). Brown rot is most often associated with gymnospermous wood (Gilbertson, 1980). The limited ability of these fungi to degrade lignin seems to account for the

absence of any localised erosion of the cell wall. Wood infested with brown rot can be greatly weakened even before decay is visible. The final stage of wood decay by the brown rots can be identified by:

- The dark brown color of the wood.
- Excessive shrinkage.
- Cross-grain cracking.
- The ease with which the dry wood substance can be crushed to a brown powder. Therefore, brown rot-decayed wood, when it is dry, is sometimes called as "dry rot" (DE-Groot, 2007).

White Rot:

White rot fungi, which break down both lignin and cellulose, have a bleaching effect that may make the damaged wood to appear more whiter than normal. Affected wood shows normal shrinkage and usually does not collapse or crack across the grain as seen in brown rot damage. However, wood invaded by white rot fungus loses its strength gradually until it becomes spongy to touch. Sometimes, white rot fungi cause thin, dark lines around decayed areas, referred as zone lines. White rot fungi usually attack hardwoods, but several species of it can also cause decay to softwoods. The lignolytic potential of white rot fungi and their adaptation to the more complex structure of angiospermous wood results in a very wide range of degradation modes. In the past, two broad divisions of white rot have been widely accepted: (1) selective delignification, and (2) simultaneous rot. In selective delignification, lignin and hemicelluloses are degraded earlier in the decay process than cellulose. Delignification is initiated by hyphae growing in the lumen, (i.e. on the inner cell wall surface) and later into the middle lamellae so that the cells tend to seperate (Blanchette, 1980; Blanchette, 1984a, b; Rayner and Boddy, 1988; Eriksson *et al.*, 1990; Schwarze and Fink, 1998; Lehnringer *et al.*, 2010). In simultaneous rot, lignin and structural polysaccharides, including cellulose are degraded at similar rate by hyphae from the cell lumen towards the

middle lamellae. Erosion troughs beneath hyphae extend deeply into the secondary wall, degrading the S_1, S_2 and S_3 layers in succession (Liese, 1970; Rayner and Boddy, 1988; Eriksson *et al.*, 1990; Koyani *et al.*, 2010, 2011).

Some species of white rot fungi also called as white pocket rot, attack the heartwood of living trees. The decayed wood contains numerous small, spindle-shaped, white pockets filled with the fungus. These pockets are generally 1/8 to 1/2 inches long (Sinclar and Lyon, 2005). Sometimes, pattern of wood decay by Basidiomycetes may differ from its characteristic white rot prototype (Schwarze and Engels, 1998; Lehnringer et al., 2010; Koyani *et al.*, 2010, 2011). For a range of different host, *Inonotus hispidus* - a white rot Bacidiomycetes forms cavities that are characteristic of soft rot decay (Schwarze and Engels, 1998; Koyani *et al.*, 2010).

Soft rot fungi:

Soft rot is caused by fungi belonging to Ascomycetes and Fungi Imperfecti (Kirk, 1974). The term soft rot emanates from the fact that there is a softening of the surface layer when wood is attacked by this group of fungi. In the secondary wall of the attacked wood cylindrical cavities with conical ends appear. The term soft rot is now used whenever this characteristic cavity pattern occurs, even if no softening of the surface layer has taken place. Soft rot is more common in hardwood than in softwood species. It has been suggested that the reason for this is the quality differences in the lignin of hard and softwoods. The methoxyl content of hardwood lignin is usually higher, about 21% , than in softwood lignin where the methoxyl content is about 14%. They are most commonly found in rotting window frames, wet floor boards and fence posts, etc. The characteristic feature of soft rot is the pattern of development which involves T-branching or L-bending and hyphal tunnelling inside lignified cell walls. This distinctive mode of attack was described by Schacht (1863) and was elucidated by Savory (1954). Soft

rot have generally been attributed to the Deuteromycetes and Ascomycetes fungi and not to the Basidiomycetes (Blanchette, 1992). Recently, an unusual type of cavity formation reminiscent of soft rot, preceeded by selective delignification, was described for a range of different host-fungus combination (Schwarze and Engels, 1998; Lehnringer *et al.*, 2010).

Molds (Non Wood Decaying Fungi):

Molds are microscopic fungi that live on plant or animal matter. The presence of surface molds can be confused with wood decay fungi. Although, molds may discolor the wood, they do not break down wood fibres and thus do not deteriorate its structure. However, these organisms generally indicate a moisture level in the wood and also support the growth of wood decay fungi. Molds can also increase the capacity of wood to absorb moisture and open the door for an attack by wood decay fungi (Kaarik, 1980). However, by using different moisture control methods which inhibit growth of molds, also inturn reduce the growth of fungi and thus prevent biodegradation of wood. Differences in mode of action and damage are briefed in Table 1.

Type	Agent	Colour	Texture	Chemistry
White rot	Basidiomycota	Bleaching	Fibrous	All components removed
Brown rot	Basidiomycota	Brown	Fibrous texture lost early, cross checking	Carbohydrates removed, lignin remains
Soft rot	Ascomycota and Deuteromycota	Bleached or Brown	Usually on surface,some fibrous structure lost,cross checking in some cases	Carbohydartes preferred, but some lignin lost too

Table 1: Brief mode of action of rot fungi.

Damages in wood due to decay:

Toughness and weight loss have been considered the most sensitive indicators of the degree of wood deterioration caused by decay. Other negative effects are observed and experienced due to unexpected changes in the wood properties after infestation. These changes are:

- Weight loss.
- Strength loss.
- Increased permeability.
- Increased electrical conductivity.
- Reduction in volume.
- Changes in pulping quality.
- Discoloration.
- Reduction in caloric value.

Wood decay fungi cause damage resulting in billions of dollars being spent on repair and replacement of wooden structures every year. The equivalent of 1/10 of the forest products produced every year is estimated to be destroyed by the fungi. Although wood degradation results in an enormous waste of resources, without wood degrading organisms our world would have been buried under cellulose and lignin debris, as these organisms are among the few that efficiently recycle lignocellulosic carbon (Kanmani, 2009). However, in recent years some of the mechanisms employed by microorganisms to degrade wood have been used in bioindustrial processes to benefit human beings. For example, fungal based oxidative reagents are used in biopulping and biobleaching processes, while other microbial enzymes are used in systems ranging from wastewater cleanup to the production of fuels from biomass. Wood decay fungi produce a variety of low molecular mass substances that are secreted from the mycelia or derived from wood components. These extracellular enzymes have important commercial values in paper, kraft, wine and other wood industries. Wood degrading agents not

only cause many problems but also greatly benefit mankind. With greater knowledge of their capabilities and potential we will be able to find better controls for their unwanted actions and direct their biochemical mechanisms to desirable applications.

Different applications of fungal byproducts in industries and worldwide rapid economical development initiated extensive studies on the production of fungal enzymes. Moreover, several enzymes have been marketed by leading international companies. According to leading market analysts, world enzyme market demand has cover nearly $5.1billion in year 2009 and demand will rise 6.3% annually through 2013 driven by strong demand in the speciality enzymes segment covering therapeutics as well as commercially important enzymes (NREL, 2010). Some of the fungal enzymes, such as amylase (Maltogenase) and lipase (Lipolase) were the first biotech enzymes marketed in the 80's. Enzymes are widely used and are available in different forms, it is still only about 25% of them, which have actually been industrialised and commercialised. Some of them are Amylase, Lipase, Cellulase, Glycomylase, Glucose Isomerase, Chymosin, Lactase, Pullulanase, Xylanase, and Protease, etc. These enzymes are sold in different industrial segments such as detergents, food, feed, pharmaceutical, and biofuels. For example, in the feed industry, enzymes help pigs or chickens to digest their food better which in the end help producing better meat, when the fodder is used in smaller amounts.

According to surveys in nutraceutical market, in the digestive health it is likely that enzymes will become a new force in the dietary supplement industry (Defelice, 1995). With a long history of dietary supplement use, it is likely that the newer research released over the past few years will assist in acceptance among consumers as a multifunctional ingredient with multiple health benefits.

Carbohydrases and proteases will continue to be the most widely used product types in part because of extensive use of these enzymes in the processing of natural materials. However, the fastest growth will come from the increasing development and use of other types of enzymes, particularly for pharmaceutical applications. In developing countries of Asian continent, enzyme market will grow faster with animal feed enzymes covering the maximum market.

Historically, enzyme demand has been concentrated in the more developed economies due to the high value-added nature of enzymes, and the significant technical resources needed for their development, production and application. However, developing countries of Asian continent like India and China, with strong research and development programs will play a major role in the world market to forward and offer some of the best growth opportunities.

In comparison with the world market, the use of enzymes in India is rather limited. However, Indian enzyme market is growing, because of increased awareness of eco-friendly processes. In the enzyme market Indian players include Biocon India, EPIC Enzymes, ABL Limited, etc.

Although, number of studies on enzyme production are carried out using submerged fermentation but Solid State Fermentation (SSF) holds tremendous potential for the production of enzymes. It can be of special interest in those processes where the crude fermented products may be used directly as enzyme sources.

Solid State Fermentation is defined as the process of fermentation, which involves solid matrix and is carried out in absence or near absence of free water. However, the substrate must possess enough moisture to support growth and metabolism of the microorganism (Singhania *et al.*, 2009). The solid matrix could be either the source of nutrients or simply a support impregnated by the proper

nutrients that allows the development of the microorganisms. The potential of SSF lies in bringing the cultivated microorganism in close vicinity of substrate and achieving the highest substrate concentration for the fermentation. SSF resembles the natural habitat of microorganisms and is therefore, preferred choice for microorganisms to grow and produce useful value-added products. Submerged fermentation (SmF) can be considered as a violation to their natural habitat, especially of fungi. SSF reproduces the natural microbiological processes like composting and ensiling. On one hand by utilizing the low cost agricultural residues for SSF adds on to economic feasibility of the process and on other hand it solves the problem of its disposal which otherwise cause pollution. Moreover, SSF has an advantage in terms of less space requirement, cheaper cost and abundant of agricultural wastes available as substrates for production of enzymes. Furthermore, it includes simplicity of the fermentation media, with fewer requirements of complex machinery, equipment and control systems, greater product yield; reduced energy demand, lower capital and low recurring expenditures in industrial operation (Pandey, 1992).

There has been a continuous extension of SSF arena, for the development of bioprocesses in the field of bioremediation and biodegradation of hazardous compounds. In recent years, with gain in interest in SSF production of value-added products such as bioactive secondary metabolites, plant growth factors, enzymes, organic acids, biopesticides, biosurfactants, biofuels, aroma compounds, etc. has also increased (Pandey, 2003). Biological detoxification of agro-industrial residues, biotransformation of crops and crop-residues for nutritional enrichment, and biopulping by SSF have been prime focused in research fields. Though, SSF is known since several years, it has gained a fresh attention all over the world since recent few years, mainly due to the advantages it offers over liquid (submerged) fermentation (Binod *et al.*, 2007; Pandey, 2007). Apart from the production of food, feed, fuel and traditional bulk chemicals, it has attracted an attention

particularly in areas of solid waste management, biomass energy conservation and its application to produce high value low volume products such as biologically active secondary metabolites, etc. (Pandey *et al.*, 2007). Capability of genetic manipulation of fungal strains has broadened horizon for SSF enabling the technology for the production of recombinant proteins and value-added chemicals. Various enzymes and organic acids have been successfully produced employing SSF (Kota, 1999; Kashyap *et al.*, 2002; Luccio *et al.*, 2004; Sumantha *et al.*, 2005; John *et al.*, 2006; Binod *et al.*, 2007). Spores are designated as small reservoirs of metabolites. It can also be used as biocatalyst for bioconversion reactions, and as biocontrol agents. Spores production is the only process where SSF dominates over SmF in all aspects such as, better yield, morphology, high stability and various other properties (Ramachandaran *et al.*, 2007). Biorefineries have added more value to SSF, as biomass is the only foreseeable source of energy to meet needs of the future generation, which adds to the importance of agro-residual waste (Sukumaran *et al.*, 2005; Singhania *et al.*, 2007). Cellulase production by SSF using agro-industrial residues for biofuel applications is in great demand. Employing packed bed, anaerobic packed bed and fluidized bioreactor, production of hydrogen, organic acids, ethanol and bio-diesel have been successfully materialized using either solid substrate or solid support (Hama *et al.*, 2007; Wu *et al.*, 2007; Jo *et al.*, 2008).

India is an agricultural country and millions of tons of agricultural biowastes have been generated after harvestation. Different agricultural wastes like wheat straw, rice straw, corn straw, paddy straw etc. contribute to millions of tons wastes in a year. Based on the enormous amount of wastes, there is an urgent need to manage the bulk wastes effectively and economically. At the same time, it is also necessary to generate value-added products from these wastes. Thus, enzyme production from these agricultural wastes not only decreases the deteriorating impact of agricultural waste on environment but also production of

value-added products will be possible. Therefore, looking to all these aspects and applications, main aim of present investigation is screening of some wood rot fungi for the production of commercially important enzymes, secondary metabolites production and *invitro* study on the pattern of delignification in some commercially important timbers by the selected fungi. Detailed objectives of the present investigation are as follows:

- Isolation, purification and characterization of rot fungi.
- Optimisation of growth media.
- Screening of pure cultures for various enzymes and secondary metabolites.
- Production of enzymes by Solid State Fermentation.
- Isolation, purification (Complete/Partial) and characterization of different enzymes.
- To study enzyme kinetics (effect of Temperature, pH, Substrate concentration and Inhibition studies, etc).
- Molecular characterization of enzymes through electrophoresis.
- *Invitro* testing of isolated fungi for wood decay.