Wood is considered as a natural gift for human which provided by the trees. During the historic period and in modern era, wood is an important natural building material, chemical raw material for the production of charcoal, tar and pitch. Now days, wood is utilizing in converted forms such as plywood, particle board and fibre board. It is also valuable raw material for pulp and paper industry. In pulping industry fibres are blended to produce uniform end product. The construction industry relies on the grading of timber. These processes in wood show its economic implications. Wood is undoubtedly the most versatile raw material which obtained from forest and available to human. It is considered as biosynthetic end product of cambial growth in the trees. The chemical composition wood differs from species to species. It is the natural composites of cellulose fibres and embedded in the matrix of lignin which resists the compression. Wood mostly contains cellulose, lignin and hemicelluloses. On the basis of lignin, wood derived in two categories: hardwood derived from sinapyl alcohol and soft wood derived from coniferyl alcohol (Valencia et al., 2006).

India has a rich variety of tree species and each tree wood has unique structure, physical and mechanical properties. The differences in wood structure and properties allow for the manufacture of wood-based products with many different appearances and uses. The wood is economically important plant tissue which is a major source of terrestrial biomass (Plomion et al., 2001). Wood and its based industry play very vital role in shaping the robust growth of the Indian Economy. The steady increase in the demand of wood resulted in constantly increasing the pressure on forest.
Wood Source

There are many hardwood and softwood tree species which provide the wood for various purposes. Many tree species that yield timber in India are Acacia nilotica, Casuriana spp., Dalbergia sissoo, Gmelina arborea, Mangifera indica, Morus spp.,Pinus roxburgii, Pterocarpus marsupium Quercus spp., Shorea robusta, Terminalia arjuna, Tectona grandis etc (Manikanandan and Prabhu, 2009).

The first documentation of Cedrus fossil genera postulated the earliest divergent among the family Pinaceae (Miller, 1976). Cedrus deodara (Roxb.) G.Don (deodar), also named as Indian cedar and considered as the most important Indian conifer. It is an important timber species and grows in Western Himalayas at elevation ranging from 1200 m to 3050 m which covers an area of about 0.2 million hectares in India (Jammu & Kashmir, Himachal Pradesh and Uttarakhand). Indian Cedar is a large evergreen conifer, reaches at 40-50 m tall and 3 m diameter in trunk. The species has the great economic importance for its timber and had been subjected to exploitation for centuries. It is demanded heavily as building material because of its fragrance, durability, rot-resistant characters and fine close grain which is capable of taking a high polish. Its rot-resistant character also makes it an ideal wood for constructing wood materials. The species play an important role in maintaining ecosystem stability of the Himalayan region. Natural deodar forests are under great pressure due to human impact and changing weather conditions (Tiwari, 1994).
Wood Formation

All living things including plants grow via cell division, elongation and expansion. However, in a relatively unique manner, the process of organogenesis constantly undergoes throughout the plant's lifespan (Clark et al., 1997). This phenomenon is achieved through controlled differentiation in a cache of differentiated cells close to the apical ends of the shoot and root, referred to as the shoot apical meristem (SAM) and root apical meristem (RAM) respectively. The SAM and RAM are responsible for growth in the vertical plane. The SAM is responsible for production of leaves, inflorescences, and primary vasculature while RAM is responsible for the production of the roots. Besides primary growth meristems, most plants also have secondary meristems which lead to growth in the lateral plane (Clark et al., 1997).

There are two secondary meristems; the cork cambium and the vascular cambium. The cork cambium produces cork to its exterior and ground tissues to its interior. The vascular cambium produces two types of vasculature; phloem on its exterior and xylem on its interior. These tissues will eventually mature into secondary vascular tissues such as inner bark and wood respectively. The cork consists of dead and heavily waxed cells. It is produced to prevent desiccation and allow the gas exchange. The secondary vasculature is developed to increase the ability of water and gases (via the xylem), solutes (via the phloem), to be transported throughout the plant body. The secondary vasculature is also responsible for mechanical support to the trees (Mackenzie and Howard, 1986). Wood is the end product during the maturation of secondary xylem. It is followed by the gradual establishment of a secondary cell wall, composed of lignin, hemicellulose and cellulose (Mellerowicz and Sundberg, 2008).
The microscopic view of deodar’s secondary xylem (wood) structure showed the narrow and distinct growth rings (Pearson and Brown, 1932 and Greguss, 1955). Deodar wood is mainly organized by cells and cell walls which are composed of microfibrils of cellulose (40-50%), hemicelluloses (15-25%) and lignin (15-30%) (Baucher et al., 1998). Lignin content is higher in softwoods (27-33%) than in hardwood (18-25%) and grasses (17-24%). The nature wood of deodar tree is soft to moderately hard. It is the strongest among coniferous woods. Besides being an important timber, deodar is non refractory timber which has fewer tendencies to surface cracking and end-splitting (Vanholme et al., 2010).

Earlier research showed that many attempts were made for genetic improvement of trees to improve productivity and quality of timber. Tree improvement programme contributed significantly by developing the improved germplasm for plantations. Various biotechnological tools are now available for the advancement of tree improvement efforts. Molecular markers are useful in estimating genetic diversity for population, individuals etc. Trait specific markers help in early selection of superior genotype. Many studies are available on the molecular mechanisms or genes which involved in various biotic and abiotic stresses, growth and development etc. Development of bioinformatics is now also helping breeders in identification of genes responsible for important traits.

**Genes for Wood formation and Quality**

There were many published studies which aim to work on the morphological and anatomical aspects of wood in conifers due to the usage as timber and resins. The lignin content provides the mechanical
strength to the wood. In spite of the importance of *C. deodara* forests, limited information is available on its basic biology.

Multifarious importance of deodar makes the researcher eager to learn on its molecular aspects. Panetsos *et al.* (1992) carried out first analyses on allozyme variation of cedar species which showed that considerable intra and inter-specific genetic differentiation exists, except for *C. deodara* where lack of variation was noticed. On the other hand, Mishra (1996) detected a minor polymorphism in natural populations of *C. deodara* from Himalayas.

Wood properties are governed by gene and protein expression during the process of xylogenesis. During the environmental response, gene regulation showed the variation (Whetten *et al.*, 2001). The cell wall, biochemical traits, fibre properties (micro fibril angle) and quality (density, stiffness) in wood of loblolly pine were governed at molecular level (Neale *et al.*, 2002).

Genes affects the wood properties such as cell wall thickness, wood-specific gravity, microfibril angle, fiber length, lumen diameter and chemical compositions included cellulose, lignin and hemicelluloses. Therefore, the genes are specific target to improve wood quality through the tree breeding and genomics. Palle *et al.* (2011) analyzed the genes in *Pinus taeda* for cellulose synthesis and callose synthase (*CaS1, CaS3, CesA1, CesA2, CesA3, CesA4, CesA5, CesA6, CesA7, CesA9, CesA10, CesA12, CslA1, CslA2*). The lignin biosynthesis pathway well known phenylpropanoid pathway determines the wood quality includes the genes named as: *4CL, CAD1, COMT, CCoAMT, C3H, CCR, PAL1, TC4H, Lac1, Lac2, Lac3, Lac4, Lac5, Lac6, Lac7, Lac8, SAD*. The cell expansion process in wood covered by genes named *COB, Exp-1, Exp-9, KORRI* (Palle *et al.*, 2011).
Molecular mechanisms of deodar can also be studied on the *in silico* level by applying the bioinformatics techniques. Upcoming disciplines like genomics in genetics are concerned with the study of genome of different organisms and are the most important domain of bioinformatics. Gene structure, location on chromosome can be studied through the genome sequencing. The ongoing sequencing projects of different genomes of organisms, generates huge amount of sequences which is processed in a systematic way to get the useful information. Coding regions in genome (genes) contain the information regarding the protein which plays important role in different pathways of lifecycle. The computational approach in genetics can solve the problems related to gene identification, primer designing, biological image analysis and back translation of proteins. Lin *et al.* (2010) reported the sequence of cpDNA of *C. deodara* (size is 119 Mbp) which contains 114 genes out of which 75 are protein-coding, 35 tRNA and 4 rRNA, and these genes resemble with the genes of *Pinus koraiensis* through the comparative analysis. The cpDNA of deodar strongly indicate representative genera of Abietoideae which make the monophyletic group (Price *et al.*,1987).

A number of comprehensive collections of information related to the gene expression and protein function now exist. Due to the rapid progress in discovering and characterizing the novel genes and proteins, the World Wide Web (www) has become one of the primary sources of up to date information. Most central databases are: The International Nucleotide Sequence Database Collaboration comprising the three sister databases, Genbank (Benson *et al.*, 2002), EMBL nucleotide database (Stoesser *et al.*, 2002), and DNA Databank of Japan (Tateno *et al.*, 2002), organize to make available all publicly available DNA sequences which included the sources, references, biological features and feature qualifiers. The aim of this research includes the development of publicly
accessible database which provide the information for wood genes and molecular traits with species.

The primary focus of the present work is to identify genes controlling wood quality traits in *C. deodara*, one of the most important softwood species planted for timber production. The aim of this study is to analyze the wood gene orthology at molecular level through approach of computational based comparative genomics. The information derived from this study will provide the starting point of unravelling the molecular mechanism of wood quality. To date there have been limited reports on global examination of gene expression profiles in wood traits. Comparison of gene expression profile in wood fibre tissues between trees with extremes of particular wood or fibre trait may provide clues to the genes controlling important wood traits. Here, the work focuses on the identification of gene (*SAD* and *4CL*) which participates in lignin biosynthesis pathway of deodar through the *in silico* approach. The *in silico* analysis includes the orthology identification throughout the genome. The orthology revealed the gene duplication of a species among the genomes in members of either same or different genera/family. Therefore, work was taken up with the below specified objectives.
OBJECTIVES

1. Identification of wood quality genes of *Cedrus deodara* using bioinformatics tools.

2. Validation of potential genes identified through microarray and upstream analysis for understanding the regulation.

3. Genetic divergence analyses between the identified genes and sequenced genome of *Populus, Pinus* and *Eucalyptus* species.

4. Development of upgradable database for wood quality traits.