**SUMMARY**

Bamboo is one of the fastest growing plants on the earth. It is considered as the most suitable alternative to plastics and wood products. They are important raw material for paper and pulp, mats, ladders, floating fenders, furniture, handicraft articles, baskets, industry and other infrastructural applications. The industrial consumption of bamboo requires mass storage for securing the continuous supply of raw material which is subject to gradual damage by decay fungi, sap stain and borers during such storages. Bamboo being susceptible to degrading organisms during usage calls for periodic replacement of the bamboo. Thus for the high end use application of bamboo, treatment with preservative solution is imperative. Numbers of commercial preservatives (CCA, CCB, AAC, TBTO, PCP, etc.) are available in the market to increase the durability of bamboo but they are proven to have negative effects on environment and human beings. This prompts an alternative method of control and protection of bamboo through plant extracts against the bamboo degradation agents need to be worked out. The studies were conducted with following objectives:

**OBJECTIVES OF THE STUDY**

The results are summarized below:

Sequential extraction of chir pine needles revealed presence of high percentage of extractive in hot water (1.62%), followed by methanol (1.59%) and acetone (0.75%) and very low percentage of extractive in petroleum ether (0.29%).

Qualitative analysis revealed presence of high level of phenol, terpenoid, flavonoid, alkaloid and tannin in methanolic extract. Carbohydrate was detected only in hot water extract with slight presence. The presence of functional group (phenol, terpenoid, flavonoid, alkaloid, tannin and carbohydrate) in other extracts i.e. petroleum ether, acetone and hot water were found to be substantially low and the functional group like flavonoid, alkaloid and carbohydrate were absent in petroleum ether extract.

Three bamboo decaying fungi were collected from bamboo depots and storage yard of Akuluto Range, Zunheboto District, Nagaland. The fungi were identified with the help of available monographs and expertise and they were reported namely *Xylaria acuminata* Hill: Schrank, *Hypoxylon rubiginosum* (Pers.) Fr. and *Hypochnicium punctulatum* (Cooke) Erikss.
In order to determine the efficacy of methanolic extract of chir pine needles, preliminary trial was carried out against two different species of wood decaying fungi i.e. *Trametes versicolor* L: Fr. and *Oligoporus placentus* Murr. through Petri plate bioassay. Methanolic extract of chir pine needles exhibited 100% growth inhibition against *Trametes versicolor* and *Oligoporus placentus* at 1.0% and 3.0% concentration respectively.

The efficacy of methanolic extract of chir pine needles was also evaluated on three different species of bamboo decaying fungi viz. *Xylaria acuminata*, *Hypoxylon rubiginosum* and *Hypochnicium punctulatum* through Petri plate bioassay. Methanolic extract of chir pine needles at 2.5, 2.5 and 3.0% concentration, recorded 100% mean growth inhibition against the test fungi *Xylaria acuminata*, *Hypoxylon rubiginosum* and *Hypochnicium punctulatum* respectively.

On the basis of preliminary screening tests of methanolic extract of chir pine needles by poisoned food technique in Petri plate, three higher concentrations (5, 6 and 7%) of the extract were used to evaluate its efficacy on bamboo (*Bambusa bambos* (L.) Voss) blocks by soil block bioassay against the bamboo decaying fungi *Xylaria acuminata*, *Hypoxylon rubiginosum* and *Hypochnicium punctulatum*. At highest concentration i.e. 7% (methanolic extract of chir pine needles), 1.79% mean weight loss was recorded in bamboo blocks as compared to control which exhibited 8.33% mean weight loss against *Xylaria acuminata*. The control bamboo blocks subjected to *Hypoxylon rubiginosum* exhibited 13.79% mean weight loss, whereas, the blocks treated with 7% concentration of methanolic extract of chir pine needles exhibited mean weight loss of 2.67%. Bamboo blocks treated at highest concentration i.e. 7% (methanolic extract of chir pine needles) recorded mean weight loss of 1.42% as compared to control which exhibited 9.19% mean weight loss against *Hypochnicium punctulatum*.

Three different concentrations i.e. 5, 6 and 7% of methanolic extract of chir pine needles were used to evaluate its efficacy on bamboo (*Bambusa bambos*) products (Pen stand) against the bamboo decaying fungi *Xylaria acuminata*, *Hypoxylon rubiginosum* and *Hypochnicium punctulatum*. The bamboo products treated with higher concentration i.e. 7% of methanolic extract of chir pine needles exhibited 46.66% fungal (*Xylaria acuminata*) infestation as compared to control (83.33%). Fungal (*Hypoxylon rubiginosum*) infection of 40% was recorded on bamboo products which were treated
with higher concentration i.e. 7% of methanolic extract of chir pine needles. Whereas the control exhibited 86.66% fungal infection. Untreated bamboo products subjected to fungus *Hypochnicium punctulatum* exhibited 76.66% fungal infection. Whereas, the bamboo products treated with higher concentration i.e. 7% of methanolic extract of chir pine needles exhibited 40% fungal infection.

The bamboo splits were treated with different concentration i.e. 5, 6 and 7% of methanolic extracts of chir pine needles. The treated and control samples were subjected to bamboo ghoon borer through larva transfer method. At higher concentration i.e. 7% of methanolic extract of chir pine needles exhibited 91.66% mean mortality of bamboo ghoon larvae. Whereas, in control sample 5.55% mean mortality of bamboo ghoon larvae was observed.

The present study shows potential antifungal and anti-borer of methanolic extract of chir pine needles for bio-protection of bamboo and its products.