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COMPARATIVE STUDY ON THE CONSTITUTENTS OF SOUND AND DISEASE AFFECTED SISSOO (*DALBERGIA SISSOO* ROXB) WOOD

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Abstract: A comparative study has been conducted on the constituents of sissoo (*Dalbergia sissoo*) wood to find out the effect of causal agent of massive mortality. Ten ideal pieces of affected and four pieces of sound wood were collected from different plantations. The sawdust of both sound and affected wood was freed from extractives with alcohol benzene mixture in a soxhlet apparatus. Cellulose and hemicellulose were determined by treatment of 10% sodium hydroxide, acetic acid and ethyl alcohol, and lignin by 72% sulfuric acid and phosphoric acid mixture. Distinct variations were found among the constituents of sound and affected sissoo wood. Hemicellulose and lignin content of affected wood were found 5.5 and 7.5% lower than those of sound wood respectively. The causal agent of massive mortality brought about these differences on account of the degradation and decomposition of lignin and hemicellulose.

Keywords: *Dalbergia sissoo;* Wood constituents; Sound wood; Massive mortality; Wood technology

Introduction

Sissoo (*Dalbergia sissoo* Roxb.) belongs to the family Leguminosae, sub family papilionoideae and is found throughout the sub-Himalayan tract from Indus to Assam. It is planted almost all over Pakistan, Assam and also in Bangladesh. No other timber species, except teak is extensively planted throughout Indo-Pak-Bangladesh (Troup, 1921). It is an important multi-purpose tree species. Its timber is very suitable for cabinet and furniture making. It is an excellent species for Agroforestry and Farm forestry as it improves soil productivity by fixing nitrogen. But an unknown disease that causes massive mortality of sissoo over North Bengal and Southwestern part of Bangladesh is affecting maximum sissoo plantations. Some important symptoms of the disease are secretion of dark or brown ooze from the trunk, wilting of twigs from the tip, yellowing of leaves, wood discolouration and coppicing from the collar region. If a tree of any plantation is affected once by the causal agent, it spreads all over the plantation and causes massive mortality of sissoo. This is a serious harm and thus an economic loss of the farmer and a great threat to the environment. In this study, comparison between the content of constituents of sound and affected sissoo wood is done by chemical analysis of wood to find out which constituents are affected and decomposed by the causal agent. This is an indirect method to identify the cause of massive mortality of sissoo.

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Materials and Methods

Ten pieces of affected and four pieces of sound sissoo wood were collected from different affected and healthy sites by wrapping with polythene to prevent further contamination. Sawdust was prepared by the electric circular saw after debarking and cleaning the pieces of wood and dried in oven over night. Three replications of each oven dried sample were taken for chemical analysis by measuring with balance after cooling in a desicator. It is mandatory to make sawdust extractive free before the determination of wood constituents. Extractives were extracted with alcohol-benzene mixture in a soxhlet extraction apparatus. Ether was used to remove the remaining solvent that is not easily washed by deionized water. Extractive free and oven dried sawdust was taken for determination of cellulose and hemicellulose by using 10% sodium hydroxide (NaOH), acetic acid and ethyl alcohol and for determination of lignin by treating with mixture of 72% sulfuric acid and phosphoric acid. For heating, measuring pH and temperature of solution, hot plate, pH meter and thermometer were used respectively. Crucible sinter was used to determine cellulose, hemicellulose and lignin. The extraction procedure was followed according to Browning, 1967.

***Determination of Extractives**:* Eight and five grams of oven dried sawdust were taken in each thimble paper and placed in a soxhlet apparatus containing the mixture of two parts (by volume) of benzene and one part of alcohol. The temperature was maintained at 100° C for constant boiling of the mixture and continued for 6 hours to complete removal of extractives. The solvent was removed from the sawdust as far as possible by normal suction and then the sawdust was rinsed with ether to remove remaining alcohol-benzene mixture that was absorbed strongly by the sawdust and was not easily removed by direct drying. The residue of the sawdust was dried in oven at 105 ± 1° C temperature over night and cooled in a desicator before weighing. Difference between the two weights was the amount of extractives that was calculated in percentage.

Determination of Cellulose and Hemicellulose: Approximately 2 gms of extractive free sawdust of each sample was taken in 200ml flask. 100ml of 10% sodium hydroxide solution was added to each sample. The flask was stirred thoroughly every 10 minutes following the addition of 5-drop of acetic acid to enhance the reaction closing the flask each time and repeating the process for 2 hours by maintaining 20°C temperature. The residues were filtered through pre-weighted crucible sinter. The Buchner flask was cleaned with 25ml NaOH solution and 25ml deionized water. The filtrate and washing was transferred to a clean 200ml graduated flask and made upto 200ml solution by adding deionized water. The residues (cellulose) were washed sufficiently with deionized water and dried in oven at 105°C over night. The weight of the residues was taken after cooling in a desicator. Then 20ml of solution was taken from 200ml solution after mixing thoroughly to a clean 80ml beaker with the help of pipette. Glacial acetic acid was added to neutralize the alkali solution. pH was checked by pH meter after stirring each addition. At the end of nutralization, 30ml ethyl alcohol was added to precipitate hemicellulose. Hemicellulose was filtrated with pre-weighted filter paper and dried in oven for 4 -5 hours at 100°C. Then it was cooled in a desicator and weighed to measure the hemicellulose content.

***Determination of Lignin**:* One gram of extractive free oven dried sawdust was taken in a small beaker and 15ml of 6:1 v/v mixture of sulfuric acid : phosphoric acid was added. The mixture was stirred with a glass rod and allowed to be gelatin 1 minute. The beaker was transferred to water bath for about 2 minutes with gentle stirring. At the first minute at 30°C temperature, care was taken to avoid splashing of sawdust on to the side of the beaker and to ensure contact with the reagent. Then the mixture was transferred to 400ml beaker and 350ml of deionized water was added slowly and stirred continuously. The content of the small beaker was washed into the large one with further 50ml water. The beaker was taken on a hot plate to boil gently for 20 minutes. Then lignin was allowed to settle for 30 minutes and filtrated into the centre of pre-weighted oven dried crucible sinter. Filtered lignin was washed with deionized water and dried at 105°C for 7 hours. The crucible sinter with lignin was cooled in a desicator before weighing. Weight difference was the amount of lignin.

Results and Discussions

Data recorded on both sound and affected wood samples were analysed and shown in Figure-1. The percentage contents of cellulose, hemicellulose and lignin of sound wood were 40-46%, 28-33% and 18-23% respectively whereas the contents of those of affected wood were between 40-52%, 16-31% and 7-18% respectively. The variation in cellulose content may be due to the decomposition and degradation of hemicellulose and lignin. The lignin content is degraded more extensively than hemicellulose. The result showed that lignin and hemicellulose content of affected wood samples were found lower in comparison with sound wood. It is evident that the causal agent degraded lignin and hemicellulose. There is a little relation of this incidence to the symptoms of white rot whereas the white rot fungi are able to degrade and decompose lignin extensively and may do so while degrading other cell wall components (Cowling, 1961). However, white rot fungi of simultaneous type involves decay of the major cell wall structural polymers (i.e. lignin, hemicellulose and cellulose) at the same time and at a similar rate, while some white rot fungi decay lignin and hemicellulose before the cellulose in the cell wall is attacked (Eaton and Hale, 1993). Examination of wood decayed by white rotters also reveal that hemicellulose is removed before or concurrently with lignin (Hoffman and Parsmeswaren, 1976; Blanchette and Abed, 1988; Blanchette *et al.,* 1989). The utilization of hemicellulose has been proposed as an important first step in the degradation of lignin (Ruel *et al*., 1981). This suggests that decay sequence for many white rot fungi may be lignin, hemicellulose and then cellulose degradation (Zabel and Morrell, 1992). Wood affected by white rot may darken in the early stages of decay but with more advanced decay bleaching may occur. It does not split into cubical fragmenmts but because of the breakdown of these lignin, it weakens interfiber bonding, and the wood becomes spongy or stringy in texture (Walker, 1993). The above discussion supports current study results and concludes that the causal agent of massive mortality of sissoo may be one of the white-rotters.

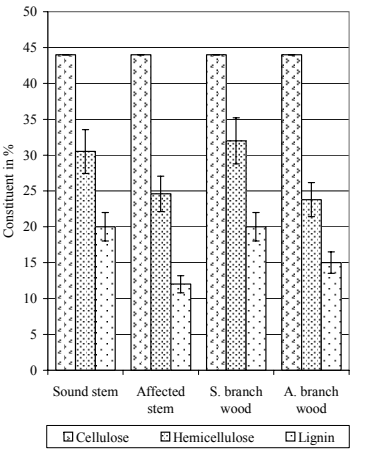

Fig. 1. Major chemical composition of sound and disease affected sissoo wood.

Conclusion

The percentage of lignin content of affected sissoo wood samples were found 7.5% lower than that of sound sisoo wood whereas the percentage degradation of hemicellulose content was found 5.5% and cellulose content increased a little proportion. This suggests that decay sequence for many white rot fungi may be lignin, hemicellulose and then cellulose degradation. The results of this study are of indicative value to ascertain and identify the appropriate causal agent of sissoo tree

mortality. Further investigation is recommended for finding the solution of this economic loss as well as concomitant damage to the environment.

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