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Research Article

FUNGAL DEGRADATION STUDIES ON *Bambusa tulda* AND *Dendrocalamus hamiltonii* AT VARYING MATURITY

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Abstract- Bamboo is the backbone of North East India. It is well known that bamboo is attacked by various groups of decay causing fungi. In the present study, resistance of *Bambusa tulda* and *Dendrocalamus hamiltonii* against *Fusarium proliferatum* (Soft rot fungi) and *Schizophyllum commune* (White rot fungi) were studied at varying stages of bamboo maturity. Three age groups of bamboo (1, 3 and 5 years) were used to test the resistance against the decay fungi. The results revealed that weight loss caused due to fungal degradation decreased significantly with age in both the test fungi. However, *Schizophyllum commune* caused greater weight loss compared to the *Fusarium proliferatum* in both the species of bamboo.

Keywords- White rot, Soft rot, Decay fungi, Fungal degradation.

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Introduction

Bamboo holds tremendous importance for the Asian countries owing to its diversity, abundance and versatile properties which make them suitable for various utilities [1, 2]. Bamboos have the ability to grow shoots from harvested culms which make them one of the best renewable resources. Factors like high growth rate, high tensile strength, low investment cost, low weight to height ratio, ease of cultivation have contributed to vast utilization of bamboos with more than 1500 record uses [3] among which the major uses are: for house or building construction, for making light bridge, scaffolding, ladder, wall, roof framing, mats, baskets, fencing, musical instruments, tool handles, kitchen utensils, furniture, handicrafts, bamboo-based panel, tools, textile, raw material for pulp and paper, medicines and bamboo shoots as vegetable [4, 5]. There are 124 indigenous and exotic species of bamboo under 24 genera naturally found in India, among which *B. bamboo* and *D. strictus* are the two genera which constitute highest portions of bamboo forests [2]. In spite of numerous excellent qualities bamboo is considered a temporary material and cannot be employed in outdoor uses unhesitatingly. Since 90% of the total mass of bamboo is made up of cellulose, hemicelluloses and lignin, it possesses susceptibility to fungal attack. Presence of high moisture content and 2-6 % starch adds to the vulnerability of bamboo culms to decay by fungi such as sap staining fungi and brown rot, white rot and soft rot fungi [6, 4]. At present, the greatest diversity of bamboo fungi occurs in Asia, as of the roughly 500 species recorded [7]. Bamboo has short maturation age compared to wood which has influence on the properties and utilization of bamboo. Li *et al.* (2007) and Espiloy (1994) discussed the relation between bamboo ageing and maturation agreeing that culm matures at age between two to three years, reaching its maximum strength [8, 9]. Anatomical and physical characteristics of bamboo culms have been known to have significant effects on their durability and strength [10, 11]. Many studies have been carried out to study decay resistance of bamboo. While Suprapti (2010) studied decay resistance of five Indonesian bamboo species against fungi. Hisham Hamid *et al.* (2012) carried out similar study on *Gigantochloa scortechinii* against white and brown rot fungi [4, 12]. Many studies have been done to analyze fungal degradation of bamboo were accomplished by Cho *et al.* (2008), Wei *et al.* (2013), Tomak *et al.* (2013) and Xu *et al.* (2013) [13, 14, 15, 16]. The resistance of bamboo against decay fungi serves as an important parameter in bamboo establishment. The objective of this study was to determine the relationship between the age and decay resistance of *Bambusa tulda* and *Dendrocalamus hamiltonii* culms. For carrying out this study bamboos from three age groups (1.0, 3.0 and 5 years-old) of cultivated *B. tulda* and *D. hamiltonii* were selected to represent young, middle aged and matured culms. The knowledge of durability of bamboo would help in its appropriate utilization and market proportion.

Materials and Methods

The culms of *Bambusa tulda* and *Dendrocalamus hamiltonii*, ages ranging from 1, 3, and 5 years old, were procured from ARCBR (Advanced Research Centre for Bamboo and Rattans), Aizawl. The specimen discs of 3cm thickness were cut from the sixth inter-node above ground level as it is considered as diameter at breast height. The green weight of specimens was noted and the moisture content was determined by the oven dry method. The specimens were kept in oven at 103±2° C for 24 hrs and then were kept in desiccator with relative humidity of 70±5 % for the next 24 hrs. This cycle was repeated till constant weight was obtained. The specimens were sterilized with propylene oxide (30% concentration) for two days prior to subjecting to degradation against the white rot (*Schizophyllum commune*) and soft rot fungus (*Fusarium proliferatum*) [12].

Determination of moisture content by oven dry method:

Specimens with wall thickness of 25 mm X 25 mm were taken at least 150 mm away from the nearest edge of the culm. The test specimens were immediately put in a polythene bag to ensure no loss of moisture. After recording the green weight (Wg) specimens were dried in a hot-air oven at a temperature of 103± 2°C for 24 hours and weighed again. The weighing was recorded every 2 hours until the difference between successive weighing did not exceed 0.01 g.

The final mass was considered as the oven dry mass (Wo). The moisture content was determined by using the formula:

$$MC\% = \frac{Wg - Wo}{Wo} \times 100$$

Durability test by weight loss method

Potato dextrose agar medium (PDA, 3.9%) was used for growing both the fungal cultures. Each bamboo specimen was introduced in a plate with full growth of test fungi. Plates were incubated at 25±2°C temperature and 70±5% relative humidity for 8 weeks. On completion of incubation period, mycelium adhering to the samples was cleaned gently with brush and samples were oven dried for 24 hrs at 103±2°C. After that specimens were kept in desiccators for 24 hrs and weighed. This cycle was repeated till constant final weight (W_f) was obtained. The decay test was carried out according to Hisham Hamid (2012) [12].

Results and Discussion

The Diameter and thickness of the samples taken from culms of *Bambusa tulda* and *Dendrocalamus hamiltonii* belonging to different age groups has been shown in [Table-1].

Table-1 *Dimensions of bamboo specimens*

Species	Age Group					
	1 (Years)		3 (Years)		5 (Years)	
	Diameter (cm)	Thickness (cm)	Diameter (cm)	Thickness (cm)	Diameter (cm)	Thickness (cm)
Bambusa tulda	5.28±0.23	0.67±0.05	5.31±0.09	0.75±0.05	5.49±0.07	0.85±0.05
Dendrocalamus hamiltonii	5.44±0.07	0.6±0.07	5.98±0.09	0.57±0.07	7.57±0.47	0.88±0.04

Bamboo possesses high moisture content which is influenced by age, season of felling and species [6]. In present study the moisture content was found to vary in samples according to the age groups. In general, moisture content tends to decrease with increase in age. Average moisture content % of 1 years, 3 years and 5 years of *Bambusa tulda* culms were found to be 100.87 %, 97.73 % and 81.06 % respectively while for *Dendrocalamus hamiltonii* the average moisture content % of 1 years, 3 years and 5 years old culms was found to be 59.43 %, 89.19 % and 48.67 % respectively. In *B. tulda* the moisture content decreased with the age though the decrement of moisture content in 3 years and 5 years old culms was not high. While the lowest moisture content % in the 5 year old culms among all the three age groups in both the species of bamboo, could be associated with the decrease in percentage of parenchyma cells (the site of water storage) within the culm [17, 18], whereas the low value of moisture content in 1 year old culms of *D. hamiltonii* may be due to the thin-walled fibres and lesser concentration of vascular bundles distributed in the immature tissues of the younger culms [19]. The results are in accordance with the study done by Liao (1990), Noggle and Fritz (1979) which established the fact that the initial moisture content tends to remain stable or slightly decreases after six months to three years of age, but increases again at the age of four years [20, 21].

Table-2 *Decay resistance of Dendrocalamus hamiltonii against fungi*

% Weight loss in *Dendrocalamus hamiltonii*			
	Fungi (A)		
Age group (years) (B)	*Fusarium proliferatum*	*Schizophyllum commune*	**Mean**
1	1.32	2.07	1.695
3	0.61	1.51	1.06
5	0.177	0.223	0.2
Mean	0.702	1.268	
	C.D.	**SE(d)**	**SE(m)**
Factor(A)	0.367	0.167	0.118
Factor(B)	0.449	0.204	0.144
Factor(A X B)	N/A	0.289	0.204

Table-3 *Decay resistance of Bambusa tulda against fungi*

% Weight loss in *Bambusa tulda*			
	Fungi (A)		
Age group (years) (B)	*Fusarium proliferatum*	*Schizophyllum commune*	Mean
1	1.55	2.22	1.885
3	0.977	1.493	1.235
5	0.537	0.903	0.72
Mean	1.021	1.539	
	C.D.	**SE(d)**	**SE(m)**
Factor(A)	0.517	0.235	0.166
Factor(B)	0.634	0.288	0.203
Factor(A X B)	N/A	0.407	0.288

The weight loss caused by both the fungi, white rot (*Schizophyllum commune*) as well as soft rot (*Fusarium proliferatum*) ranged from 0.177% to 2.22%. The highest weight loss recorded was 2.22 ± 0.99% which was caused by *Schizophyllum commune* in *Bambusa tulda* samples belonging to one year age group. Least weight loss was caused by *Fusarium proliferatum* in samples from 5 year age group which was recorded to be 0.18 ± 0.04%. The results of decrement in decay with increment in age which is similar to the results reported by Hamid *et al.* (2012) [12]. Young culms were susceptible to decay while matured culms showed higher resistance to both the fungi. The low mass loss in all the age groups was in accordance with the findings of Wei *et al.* (2013) obtained in the study carried out to investigate degradation of lignocelluloses of *Gigantochloa atroviolacea* by brown rot fungus (*Coniophora puteana*) and the white rot fungus (*Schizophyllum commune*) [14]. Youngest culms of *D. hamiltonii* exhibited least resistance against both the fungi while matured culms of 5 years age suffered negligible decay. In a study done by Schmidt *et al.* (2011) the culms of *Melocanna bambusoides* and *Gigantochloa scortechinii* from different age groups were subjected to fungal decay. The findings of their study proved that youngest culms (6 months old) were more susceptible to white rot *Trametes versicolor*, brown rot *Coniophora puteana* and soft rots than the matured culms (6.5 years old) [22]. The decay in samples from 1, 2 and 3 years old culms differed only minimally. The higher rate of decay in young culms can be attributed to higher content of carbohydrate and proteins in parenchyma cells.

Conclusion

The results obtained in this study indicate that age influenced the moisture content of *D. strictus* and *B. tulda* culms. In matured culms of both the species the moisture content was lower than the young culms. The decay resistance of both the species increased with the age, though young culms were also found to be resistant against white rot and soft rot.

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