Traditional Methods of Post Harvest Bamboo Treatment for Durability Enhancement

Bebija L. Singha and R.K. Borah

Abstract—Bamboos like all lignocellusic biomass are susceptible to biodegradation which reduce its durability. Post harvest preservation of bamboo culms is important for enhancement of its service life. But the durability of bamboo also depends on its age, species, moisture content, climatic condition and nutrient content. There is little information available under traditional preservation of bamboo in northeast India. This paper describes the traditional methods of preservation of Bambusa tulda by water soaking, curing and smoking. The efficacy of water soaking method was tested in the laboratory conditions by using Schizophyllum cummuni and Graveyard test. The average biomass loss of bamboo culms during the tests ranges from 10.81% (1 month treated) to 19.26 % (control) and 25.99% (1 month treated) and 67.66% (control) respectively and these values increases as the soaking period increases. It was found that soaking of bamboo in water for one month is optimum for enhancing the durability.

Index Terms—Traditional preservation; durability; starch; Schizophyllum cummune; graveyard test

1 INTRODUCTION

Bamboo is one of the most useful natural resources in many parts of world. It matures in 3-4 years in comparison to wood species which requires 25-80 years to attain maturity. Bamboo is a lignocelluosic biomass which is similar to properties of wood but with additional properties like easy workability, excellent strength, high elastic behavior and resistance to abrasion. Due to its versatile properties it has been named as the most important sustainable and environmentally helpful crop on the earth (Brystriakova et al. 2003). At present there are about 1575 accepted bamboo species plus several other species with incorrect names (Ohrnberger, 1999). Bamboo plays a major role in the economy of rural people and industry. They are widely used for house constructions, bridges, fencing, basketry, furniture, mats, agricultural tools, handles for tools, musical instruments, fishing rods, scaffolding, weaving material, pole and post, paper and pulp making, food for humans and livestock (Sanyal et al. 1981). Bamboos are also becoming more popular worldwide for ornamental and economic purposes (Bezona and Rauch, 1997). Some bamboo species are grown for ecological purposes like stabilization and prevention of erosion. However, its uses are limited because of high nutrient content which make it highly attractive to insect and fungi (Mathew and Nair, 1990 and Gnanarahan et al. 1993). Therefore, it is very important to give preservative treatment to bamboo to enhance its service life.

Bamboo can be preserved either by using chemicals (chemical treatment) or without using chemical (traditional treatment) to prolong their durability (Abd. Rajak *et al*. 1995). Chemical methods include washing, coating, brushing, swabbing, spraying, boucherie process, steeping, sap displacement, hot and cold bath, diffusion process, butt treatment, open tank process, pressure process by using different types of chemicals (Liese, 1980; Kumar et al. 1990 and Zaidon et al. 2000). These methods are effective but expensive and hazardous to health particularly during handling, storage and disposal if proper precautionary measures are not taken.

- *Bebija Loktongbam Singha, Research Scholar, Assam down town University, Guwahati -781026, Assam, India, PH-0919435595410. E-mail: lbebija@gmail.com*
- *Dr. Rajib Kumar Borah, Scientist-F, Rain Forest Research Institute, Jorhat-785010, Assam, India, PH-0919435051669. E-mail: borahrk@icfre.org*

On the other hand, traditional methods are age old methods followed by indigenous communities and farmers of Asia and Latin America which is eco-friendly. Traditional methods include water soaking (may be stagnant or running water), curing, smoking, whitewashing etc (Sulthoni, 1987 and Zaidon et al. 2000). Water soaking is the most popular methods which cost almost nothing and during the process nutrient is depleted from the bamboo and reduces the degree of insects and fungi attacks (Sulthoni, 1987 and Kumar et al. 1994). These methods impart resistance to bamboo against biodegrading agents but the degree of effectiveness depend on the species of bamboo, its age, moisture content, nutrient content and time of harvest (Plank 1950). Further studies done by some of the workers like Purushotham et al. 1953; Beeson, 1961; Liese, 1980; Tamolang et al. 1980 and Sulthoni, 1987, indicate that the damage caused by borers, decay fungi and termites has been proportional to the starch content of the bamboo and their attack is more in field conditions.

In this paper effectiveness of traditional methods of bamboo preservation by water soaking, curing and smoking and the amount of total soluble sugar depleted has been studied. Further, these samples were tested against decay fungi in laboratory and in field through graveyard test to study its durability in service life.

2 MATERIALS AND METHODS

Bambusa tulda (locally Jati bah) one of the most extracted bamboo species in Assam was used for the purpose of traditional or non-chemical preservation. Methods like water soaking; curing and smoking are the main traditional methods that are followed by rural people to enhance the durability of harvested bamboos before their multipurpose uses. The carbohydrates depletion during the preservation was determined by using Anthrone method (Sadasivam and Manickum, 1996) using a UV-Vis spectrophotometer (Model: Spectrascan UV 2700-Thermo Scientific).

The three different types of traditional methods of treatment are as follows:

2.1 Water soaking

Matured culms of about 3-4 years old B. tulda were cut into three equal portions, i.e., basal, middle and apical portions and each portion were further cut into 100 cm long poles. 20 numbers of poles (5 replicates) from each portion were produced and thus a total of 60 poles were kept ready for traditional preservation. Out of these 60 poles, 15 poles containing 5 replicates from each portion were given no treatment (control) for comparison with treated poles. The remaining 45 poles were divided into three groups in which each group contained equal number of poles from different portions and kept submerged in water for a period of 1, 2 and 3 months.

Before treatment all the bamboo samples were leveled giving prefixes like 0 (control), 1 (month), 2 (months) and 3 (months) for different treatment period of soaking and A (Apical), M (Middle) and B (Basal) for different portion of the culm and suffixes like 1, 2, 3, 4 and 5 as replication numbers. Accordingly, control samples were leveled as 0A1 to 0A5, 0M1 to 0M5 and 0B1 to 0B5. Similarly, the other portions were also leveled as 1A1 to 1A5, 1M1 to 1M5 and 1B1 to 1B5 for samples with 1 month treatment ; 2A1 to 2A5, 2M1 to 2M5 and 2B1 to 2B5 and 3A1 to 3A5, 3M1 to 3M5 and 3B1 to 3B5 for samples with 2 and 3 months treatment respectively.

The samples were collected from water after the completion of each treatment period and air dried under shade till a stable value of moisture content were obtained. For determination of starch content a small section from each sample was cut, powdered and sealed in polythene bags with proper level.

2.2 Curing

Matured culms of about 3-4 years old B. tulda were felled and left in the felling site along with branches and leaves attached by leaning them to a nearby tree for three different periods viz. 15, 30 and 45 days. The bases of the felled culms were put on a stone to avoid absorption of moisture from the ground. Samples in the form of saw dust were collected after each seasoning period from basal, middle and apical portions of the culms separately taking 5 replicates of each portion. For determination of starch content, the saw dust samples were sun dried and sealed in polythene bags with proper level.

2.3 Smoking

Smoking is also one of the traditional treatment methods for bamboo followed by most rural community. For this method, matured culms of about 3-4 years old B. tulda were collected and equally divided them in three different portions viz., apical, middle, basal and cut them accordingly. These different portions of culms were then

season over a traditional fire place where continuous supply of smoke and heat is given for 15, 30 and 45 days. Samples in the form of saw dust were collected after completion of each seasoning period from different portions of the culm separately taking 5 replicates of each portion for determination of starch content.

Test for durability

Two different types of test were conducted to evaluate the durability of these treated bamboo culms and compared with the untreated samples (control) by using (i) the white rot fungus - Schizophyllum cummune (Wei et al., 2013) and (ii) Graveyard method (Oduor et al., 2010). The statistical analysis of mean values biomass loss obtained from these studies were analysed by one way analysis of variance (ANOVA) and value of significance difference (SD) and critical difference (CD) at 5% according to Gomez & Gomez, (1984).

3 RESULTS AND DISCUSSION

3.1 Water soaking

Starch content in different portions of treated and untreated (control) bamboo samples by water soaking method are given in Table 1. The highest average starch content (3.64%) was recorded in the control samples as compare to the treated ones. Least average starch content of (0.50%) was recorded in 3 months treated bamboo samples. The average starch content reduces as the soaking period increases. Therefore, there is significant difference between the treated and untreated samples.

3.2 Curing

Starch content in different portions of a culm after undergoing curing method of traditional preservation is given in Table 2. The highest average starch content (3.64%) was recorded in the control samples as compare to the treated ones. Least average starch content of (1.80%) was recorded in 3 months treated bamboo samples. The average starch content reduces as the soaking period increases. Therefore, there is significant difference between the treated and untreated samples.

3.3 Smoking

Starch content in different portions of a culm after undergoing smoking method of traditional preservation is given in Table 3. The highest average starch content (3.64%) was recorded in the control samples as compare to the treated ones. Least average starch content of (2.48%) was recorded in 3 months treated bamboo samples. The average starch content reduces as the soaking period increases. Therefore, there is significant difference between the treated and untreated samples.

Durability test using Schizophyllum commune: Highest biomass loss (19.26 %) under this test was recorded in the untreated (control) samples as compared to the treated samples, and the least biomass loss (10.85%) was recorded in 1 month soaked samples (Table 4). There was no significant difference in % biomass loss among the treatments but there was significant difference when compared to control.

Durability test through graveyard method: Highest biomass loss (67.66%) after graveyard test was recorded in the untreated (control) samples as compared to the treated samples, and the least biomass loss (25.99%) were recorded in 1 month treated samples (Table 5). There was no significant difference in % biomass loss among the treatments but there was significant difference when compared to control.

Table 1: Starch content of B. tulda estimated after water soaking method

Duration of Treatment	Starch content (%)			
	Basal	Middle	Apical	Average
Control (0 month)	4.01	3.25	3.68	3.65
1 month	1.55	1.19	1.31	1.35
2 months	1.32	1.03	1.11	1.15
3 months	1.16	0.91	0.87	0.98
P-value	7.35E-07			
SED	0.104			
CD	0.203			

Table 2: Starch content of B. tulda estimated after curing method

Duration of Treatment	Starch content (%)			
	Basal	Middle	Apical	Average
Control (0 month)	4.01	3.25	3.68	3.65
15 days	4.06	3.63	2.87	3.52
30 days	2.72	3.4	2.54	2.89
45 days	2.23	1.71	1.47	1.80
P-value = 0.038				
SED = 0.51				
CD = 0.99				

Table 3: Starch content of B. tulda estimated after smoking method

Duration of Treatment	Starch content (%)			
	Basal	Middle	Apical	Average
Control (0 days)	4.01	3.25	3.68	3.65
15 days	5.41	3.45	1.35	3.40
30 days	5.05	2.13	1.21	2.80
45 days	4.66	1.89	1.12	2.56
P-value = 0.18				
SED = 0.48				
CD = 0.93				

Table 4: % biomass loss of traditionally treated B. tulda caused by Schizophyllum commune:

Sl. No.	Portion of bamboo	% biomass loss			
		Control	1 month	2 month	3 month
1	Basal	16.81	9.02	10.44	12.74
2	Middle	19.04	10.19	11.58	14.23
3	Apical	21.94	13.22	13.31	16.11
	Average	19.26	10.81	11.78	14.36
p-value = 0.000142					
sed = 0.43					
cd = 0.84					

Table 5: % biomass loss of traditionally treated B. tulda during graveyard test

Sl. No.	Portion of Bamboo	% biomass loss			
		control	1 month	2 month	3 month
1	Basal	59.37	21.69	37.09	41.90
2	Middle	65.58	27.45	38.41	46.21
3	Apical	78.04	28.83	45.89	49.24
	Average	67.66	25.99	40.46	45.78
p-value = 0.0095					
sed = 2.58					
cd = 5.01					

4 CONCLUSION

Soaking of bamboo culm in water significantly reduced the nutrient content as compare to other traditional methods of preservation. Moreover, the reduction of carbohydrates content in bamboo is positively related with the period of soaking. Longer the period of soaking lesser the carbohydrates content. Three months of soaking reduces 50-60% of sugar content in the species. During durability test it was found that of treated bamboo culms was much slower as compared to untreated bamboo culms. Moreover, least percentage biomass loss was recorded in one month treated bamboo samples during durability tests. Therefore, it can be concluded that soaking bamboo culm in water for one month is sufficient to enhance its durability in service. This method can also reduce the use of chemicals preservatives that is harmful to both man and environment.

5 ACKNOWLEDGEMENT

I do hereby acknowledge the authority of RFRI, Jorhat, Assam for permitting me to do Ph.D. in AdtU, Guwahati-26. I also would like to acknowledge the management of AdtU for providing me the all round facilities for carrying out my Ph.D. work. Especially I would like to acknowledge/ thank the authority of RFRI, Jorhat, Assam and Assam Agriculture University, Jorhat for allowing me to use their laboratories for various research work related parameters.

REFERENCES

[1] Abd. Rajak, O., M. Abd. Latif, W. Liese, and H. Norini, 1995. Planting and Utilization of Bamboo in

Peninsular Malaysia, Research Pamphlet No. 118, Forest Research Institute of Malaysia (FRIM), pp. 117.

[2] Beeson, C.F.C. 1961. The Ecology and Control of the Forest Insects of India and Neighbouring Countries. Government of India. First Reprint, pp. 767.

[3] Bezona, N.C. and Rauch, F.D. 1997. Bamboo for Forest and Garden; Hawaii Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii at Menon: Honolulu, HI, USA.

[4] Brystriakova, N., Kapos, V., Lysenko, I. and Stapleton, C.M.A. 2003. Distribution and conservation status of forest bamboo biodiversity in the Asia-Pacific Region. Biodiversity Conservation, 12: 1833-1841.

[5] Gnanaharan, R., Mohanan, C and Chand Basha, S. 1993. Post-harvest technology for reed bamboo. BIC India Bulletin, 3(1): 1-6.

[6] Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research (2 ed.). John wiley and sons, New York, 680p.

[7] Kumar, S., Shukla, K.S. and Dobriyal, P. B. 1990. Management of Biodegradation of Timber Logs and Bamboo during Storage. A review for Indian Conditions, Journals of Timber Development and Association, (India), 36: 5-14.

[8] Kumar, S., Shukla, K.S., Dev, I.; Dobriyal, P.B. 1994. Bamboo preservation technique: A review. Indian Council of Forestry Research & Education, Dehra Dun & International Network for Bamboo and Rattan, International Development Research Centre, Canada, pp. 59.

[9] Liese, W. 1980. The preservation of bamboo. In: Bamboo Research in Asia. Proceedings of IDRC sponsored Workshop held in Singapore, May 1980: 165-178, IDRC, Singapore.

[10] Mathew, G. and Nair, K. S. S. 1990. Storage pests of bamboos in Kerala. In "Bamboos: Current Research". I. V. R. Rao, R. Gnanaharan, and C. B. Sastry (Eds) Proc. International Bamboo Workshop, KFRI/IDRC, pp. 212-214.

[11] Oduor, N., Mogire, S., Wakaba, Simon N., Oduori, E. and Sigu, G. 2010. Report on development effective environmentally friendly preservation methods for bamboo for in-door and out-door use. Research paper under technology development, Kenia Forestry Research Institute, (KEFRI).

[12] Ohrnberger, D. 1999. The Bamboo of the world: Annotated Nomenclature and Literature of the Species and the Higher and Lower Taxa; Elsevier: Amsterdam, The Netherlands.

[13] Plank, H. K. 1950. Studies of factors influencing attack and control of the bamboo powder post beetle. Fed. Exp. Sta. Mayaguez, Puerto Rico. Bulletin no. 48: 39 p.

[14] Purushotham, A., Sudan, S. K and Vidya Sagar. 1953. Preservative treatment of green bamboos under low pneumatic pressures. The Indian Forester, 79(12): 652-672.

[15] Sadasivam, S and Manickam, A. 1996. Biochemical methods. A biochemistry manual published by New Age International Pvt. Ltd. Publishers.

[16] Sanyal S. N., Gulati, A. S., Khanduri, A. K. 1981. Strength properties and uses of bamboos – a review. Indian Forester, 114: 367-649.

[17] Sulthoni, A., 1987. "Traditional preservation of bamboo in Java, Indonesia". In Rao, A.N.; Dhanarajan, G.; Sastry, C.B. (Ed.), "Recent research on bamboos", Proceedings of the International Bamboo Workshop, Hangzhow, People's Republic of China, 6 - 14 October 1985. CAF/IDRC, pp. 349-357.

[18] Tamolang, F. N., Lopez, A. R., Semara, J. A., Casin, R. F., and Espiloy, Z. B. 1980. Properties and utilization of Philippine erect bamboo. In International Seminar on Bamboo Research in Asia held in Singapore, May 28-30: proceedings edited by G. Lessard and A. Chouinard. Singapore: International Development 44 Research Center and the International Union of Forestry Research Organization, pp. 266-275.

[19] Wei, D.; Schmidt, O. and Liese, W. 2013. Method to test fungal degradation of bamboo and wood using vermiculite as reservoir for moisture and nutrients. Maderas, Ciencia y tecnologia 15 (3): 349-356.

[20] Zaidon, A., Razali, A. K., Hamami, S. Mohd. and Norzaliza, Y. 2000. Improvement of Bamboo Resistance against Stain Fungus by Water Soaking. Paper to be presented at International Bamboo seminar, 2-4th August 2000, Chiangmai, Thailand, Kasetsart University and Royal Forestry Department, Thailand.