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Study of the Chemical Loading in Bamboo for Preservative Treatment to Enhance Durability using Boucherie Apparatus

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Abstract: ***Bamboo is cheap, readily available and easy to work with for various purposes like rural housing, fences, equipment and implements etc. In spite of its multifarious it has short durability due to biodegradation. To enhance its service life it is given preservative treatments by traditional method or by using chemicals. Boucherie process has been considered the best method for chemical preservative treatment of green bamboo but literature survey shows few or no reports on amount of chemical loading. This study is aimed at working out the preservative chemical (CCB) loaded in bamboo by Boucherie apparatus (Jagriti) and chemical preservative (CCB) loaded in them by chemical analysis using IS 2753 (Part 1) 1991. In Bambusa pallida a loading of 7.90 gm/kg was obtained and least of 1.40 gm/kg was obtained with 10%CCB while using the pressure of 1kg/cm^2.In D. hamiltonii the highest CCB loading observed was 8.30 gm/kg using 10% CCB under 1.5 kg/cm^2 pressure while the least was 2.30 gm/kg with 12% CCB under the same pressure condition.***

Keywords: Bamboo, Boucherie Apparatus, Chemical loading, Durability, Preservative Treatment

1. Introduction

Bamboo is an integral part of life in many parts of the world as it is cheap, readily available and easy to work with. North eastern part of India is storehouse of bamboos with about 90 bamboo species (Tewari, 1993). It has excellent strength properties and some properties of bamboos are reported to be stronger than certain structural timbers (Gnanaharan, 2000). The durability of bamboo is short (1-36 months) (Kumar *et al*., 1994) due to the presence of large quantity of nutrients etc. thus making it highly susceptible to host of biodegrading agents (Beeson, 1941; Gardener, 1945; Mathew and Nair, 1990; Mohanan, 1997; Singh, 1988; Jae-Jin Kim *et al.,* 2011). Hence, various preservative treatment methods and chemical preservatives are used to enhance its durability (Kumar *et al*. 1994). Purushotham *et al*. (1953) recommended different chemical preservatives, their concentration and absorption for treating dry and green bamboos. Boucherie process is considered one of the best methods for preservative treatment of green bamboos (Shukla & Dev, 2000; Gnanaharan, 2000). The preservative treatment time required was 30 minutes to hours with a loading of about 2 kg/cm^3 (Kumar *et al*., 1994).

The amount of preservative loaded in *Dendrocalamus strictus* has been reported to the extent of 8.6 kg/m^3, 12.8 kg/m^3 and 14.9 kg/m^3 in the basal, mid and apical portions respectively (Kumar *et al*, 1994). There is also report of the loading of 13 kg/m^3 of chemical preservative in *D. strictus* by diffusion process in the period of 10-20 days (Singh and Tiwari 1981a). The loading of chemical preservatives were worked out basing on the amount of preservative absorbed and the concentration of the preservative solution used. In this paper the amount of preservative loaded in bamboo by Boucherie apparatus (Jagriti) and the preservative (CCB) loaded were calculated by chemical analysis. The chemical analysis was done after digestion of the powdered sample and tested for amount of chromate using IS 2753 (Part 1) 1991.

2. Material and Method

The freshly harvested bamboo of *Bambusa pallida* Munro (Bijuli bah), and *Dendrocalamus hamiltonii* Nees et Arn ex. Munro (Kako bah) were sized to 1m length and given preservative treatment. The treated samples were divided into three groups viz. top, mid and bottom. All the bamboo samples were serially numbered from 1 to 70 and consecutive five samples were treated as replications under one treatment condition. Serial number 1-35 contained only *B. pallida* whereas serial number 36-70 contained *D. hamiltonii*. The bamboo samples from different portions viz. top, middle and bottom were designated as R1, R2 and R3 respectively**.** The fresh and shade dry weight of the bamboo sample was recorded using a digital balance

The selected preservative was Copper Chrome Boron (CCB) in 8, 10 and 12% concentration under 1 kg/cm^2 and 1.5 kg/cm^2. The treatment of these bamboos was done using Boucherie apparatus was as per Gurung *et al*., 2016. After recording of the final dry weight about 5 gm of the sample was cut and powdered and packed in polythene bag with the individual sample number.

In the present study the quantum of chromium present in the bamboo sample was analyzed as per the prescribed methods of IS 2753 (Part 1) 1991 (Reaffirmed 2005), Section 4.2 and 4.4.3. (Appendix 1) to calculate the amount of preservative. Due to the limitations of time and fund only chromium was done to estimate the amount of CCB loaded in grams per

100 grams of treated bamboo samples. No chemical analysis was done in untreated (control) bamboo samples.

3. Results and Discussion

The amount of CCB (gm/kg) loaded in apical, middle and basal portions of *B. pallida* and *D. hamiltonii* is presented in table 1and 2.

Table 1: Mean CCB loading (gm/kg) in *B. pallida*

Treatment Conditions	*Apical*	*Mid*	*Basal*
8% 1 kg/cm^2	6.80	7.65	5.31
10%1 kg/cm^2	3.19	5.95	1.70
12% kg/cm^2	6.16	3.40	5.53
8% 1.5 kg/cm^2	6.37	6.16	4.25
10% 1.5 kg/cm^2	7.86	4.67	4.88
12 % 1.5 kg/cm^2	5.74	5.52	3.83
Control	0.00	0.00	0.00

Table 2: Mean CCB loaded (gm/kg) *D. hamiltonii*

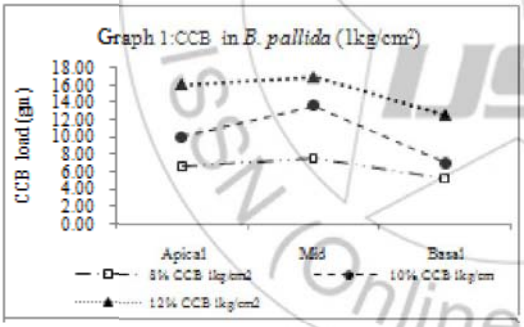
Treatment Conditions	*Apical*	*Mid*	*Basal*
8% 1 kg/cm^2	8.10	4.30	5.95
10%1 kg/cm^2	5.10	6.40	6.38
12% kg/cm^2	6.20	5.53	2.98
8% 1.5 kg/cm^2	1.10	3.20	2.98
10% 1.5 kg/cm^2	8.30	4.46	3.83
12 % 1.5 kg/cm^2	2.34	4.46	4.68
Control	0.00	0.00	0.00

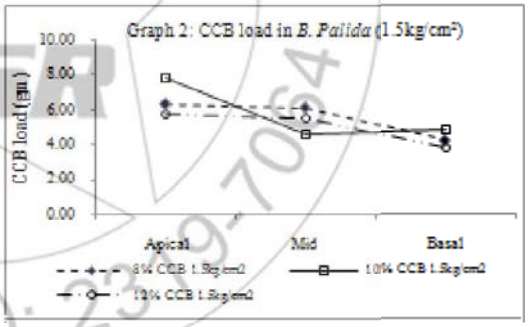
B. pallida/1kg/cm^2 pressure

Chemical analysis of bamboo (*B. pallida*) treated with 8, 10 and 12% CCB with 1 kg/cm^2 pressure is presented as Graph 1. In apical portion the highest loading of 6.80 gm CCB/100gm bamboo; followed by 6.16 and least of 3.19 with 12% and 10% respectively. In the mid portion of *B. pallida*, the loading of CCB was highest of 7.65 gm CCB/100gm bamboo with 8% CCB while loading due to 10 and 12 % CCB were 5.95 and 3.40 gm respectively. The loading of CCB in the basal portion was highest of 5.31 gm followed by 5.52 with 12% CCB and 1.70 gm with 10% CCB under 1kg/cm^2 pressure.

B. pallida/1.5 kg/cm^2 pressure

Chemical analysis of bamboo samples (*B. pallida*) treated with 8, 10 and 12% CCB under 1.5 kg/cm^2 pressure (Graph 2). The loading of CCB in the apical portion was highest loading of 7.86 with 10% CCB; followed by 6.37 gm and least of 5.74 with 8% and 12% CCB respectively. In the mid portion of *B. pallida*, the loading of CCB was highest of 6.16 gm with 8% CCB under 1.5 kg/cm^2 while loading due to 10 and 12 % CCB were 4.67 and 5.52 gm respectively. The highest loading of CCB in the basal portion was 4.89 gm with 10% CCB followed by 4.25 gm and 3.82 gm with 8% CCB and 12% respectively. High average CCB loading was observed with 8% CCB under lower pressure conditions of 1kg/cm^2.while the CCB load was higher with 10% CCB under the increased pressure of 1.5 kg/cm^2.





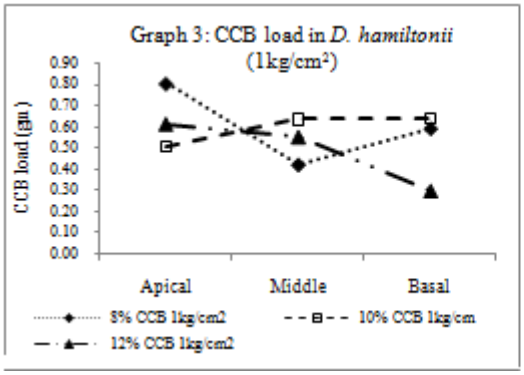
D. hamiltonii/1kg/cm^2 pressure

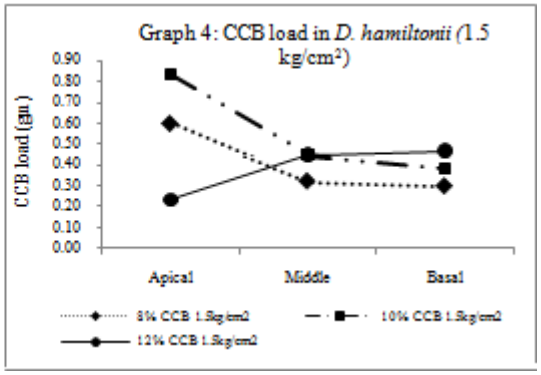
Chemical analysis of *D. hamiltonii* treated with 8, 10 and 12% CCB under 1 kg/cm^2 pressure (Graph 3) showed highest loading of 8.08 with 8% CCB; followed by 6.16 gm and least of 5.10 gm with 12% and 10% CCB respectively. In the mid portion of *D. hamiltonii*, the loading of CCB was highest of 6.36 with 10% CCB under 1kg/cm^2 while loading due to 8 and 12 % CCB were 4.24 gm and 5.52 gm respectively. The loading of CCB in the basal portion was highest of 6.40 with 10% CCB followed by 5.96 gm with 8% CCB and 2.98 gm with 12% CCB under 1kg/cm^2 pressure.

D. hamiltonii/1.5 kg/cm^2 pressure

Chemical analysis of basal portion of *D. hamiltonii* treated with 8, 10 and 12% CCB under 1.5 kg/cm^2 pressure (Graph 4) the loading in the apical portion was highest of 8.29 gm with 10% CCB; followed by 5.99 and least of 2.34 with 8% and 12% CCB respectively. In the mid portion of *D. hamiltonii* highest of 4.50 gm was recorded with 10% CCB while loading due to 8 and 12 % CCB were 3.22 and 4.48 gm respectively. The loading of CCB in the basal portion was highest of 4.68 gm with 12% CCB followed by 3.82 with 12% CCB and 2.98gm with 8% CCB respectively.

The study of preservative loading in *D. hamiltonii* with three CCB concentrations and two pressure conditions, the highest average loading of CCB was obtained under lower pressure of 1 kg/cm^2 when compared to 10 and 12% concentrations. Under higher pressure of 1.5 kg/cm^2 the CCB loading was much higher in mid and basal portions of the bamboo compared to apical portion.





The tests of significance for preservative (CCB) loaded in of *B. pallida* and *D. hamiltonii* was significant among the treatments at 0.05% level of probability (Tables: 3 to 8) except in mid portion of *D. hamiltonii* which may be attributed to post harvest delay in preservative treatments and error in chemical analysis.

Table 3: Statistical analysis (ANOVA) for CCB loaded in apical portion of *B. pallida*

Source of variation	Degree of freedom	Sum of squares	Mean squares	F calculated	F at 5%	Significance
Replication	4	0.22	0.06	1.22	2.78	NS
Treatment	6	2.17	0.36	7.94	2.51	Sig**
Error	24	1.09	0.045			
Total	34	3.48				

SED: 0.13 CD (5%): 0.23

Table 4: Statistical analysis (ANOVA) for CCB loaded in mid portion of *B. pallida*

Source of variation	Degree of freedom	Sum of squares	Mean squares	F calculated	F at 5%	Significance
Replication	4	0.26	0.06	1.09	2.78	NS
Treatment	6	1.84	0.31	5.16	2.51	Sig**
Error	24	1.43	0.060			
Total	34	3.53				

SED : 0.15; CD (5%): 0.26

Table 5: Statistical analysis (ANOVA) for CCB loaded in basal portion of *B. pallida*

Source of variation	Degree of freedom	Sum of squares	Mean squares	F calculated	F at 5%	Significance
Replication	4	0.10	0.03	0.37	2.78	NS
Treatment	6	1.27	0.21	3.01	2.51	Sig**
Error	24	1.68				
Total	34	3.05				

SED: 0.17; CD (5%): 0.29

Table 6: Statistical analysis (ANOVA) CCB loaded in apical portion of *D. hamiltonii*

Source of variation	Degree of freedom	Sum of squares	Mean squares	F calculated	F at 5%	Significance
Replication	4	0.61	0.15	4.71	2.78	Sig
Treatment	6	4.15	0.69	21.30	2.51	Sig**
Error	24	0.78	0.03			
Total	34	6				

SED: 0.11 CD (5%): 0.19

Table 7: Statistical analysis (ANOVA) CCB loaded in mid portion of *D. hamiltonii*

Source of variation	Degree of freedom	Sum of squares	Mean squares	F calculated	F at 5%	Significance
Replication	4	0.54	0.13	1.26	2.78	NS
Treatment	6	1.25	0.21	1.96	2.51	NS
Error	24	2.56	0.11			

SED: 0.21 CD: 0.35

Table 8: Statistical analysis (ANOVA) for CCB loaded in basal portion of *D. hamiltonii*

Source of variation	Degree of freedom	Sum of squares	Mean squares	F calculated	F at 5%	Significance
Replication	4	0.40	0.10	1.47	2.78	NS
Treatment	6	1.40	0.23	3.45	2.51	Sig**
Error	24	1.62	0.07			
Total	34	3				

SED: 0.16 CD (5%): 0.28

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