MYCOLOGICAL EVALUATION OF WATER SOLUBLE FIXED TYPE PRESERVATIVES FOR TIMBERS

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Three water soluble fixed type preservatives viz., copper-chrome-arsenic composition, acid-cupric-chromate composition and copper-chrome-boric composition applied on thirteen types of timbers, were evaluated for their permanence-cum-toxicity by mycological tests. The data have been statistically analysed. The results have shown that, in general, copper-chrome-arsenic preservative is superior in performance amongst these three preservatives. All the preservatives have, however, been found satisfactory in respect of specific types of timbers under leached and unleached conditions.

Wood is attacked by various wood destroying organisms. The most important of these are fungi that are responsible for decay when wood is used or stored in contact with damp ground or water[1]. The life of all native commercial species of timbers can be substantially increased by an adequate preservative treatment. The preservative treatment increases resistance of timber to fungal attack and mechanical wear by preventing the softening due to decay.

Earlier work has been carried out by Bhandari *et al*[2] on a number of preservative treatments for 16 species of timbers used for manufacture of ammunition boxes. It was found that treatment of timbers with water soluble 'fixed' type preservatives such as copper-chrome-arsenic composition, acid-cupric-chromate composition and copper-chrome-boric composition applied by 'hot and cold' bath process gave in majority of cases good penetration and retention of the preservatives. On the basis of their findings these authors recommended the use of water soluble 'fixed' type preservatives for treatment of timbers used for manufacture of ammunition boxes.

This paper summarises the results of mycological tests carried out on the 13 species of timbers both sapwoods and heartwoods treated with copper-chrome-arsenic composition, acid-cupric-chromate composition and copper-chrome-boric composition before and after leaching.

MATERIALS AND METHODS

Timbers :

The timbers used are given in Table 1.

Table 1

Timbers used in various tests

Common name	Botanical name	Type of timber	
Mango	*Mangifera indica*	Sapwood and	Heartwood
Jamun	*Eugenia jambolana*	,,	,,
Jack	*Artocarpus integrifolia*	—	,,
Chaplash	*Artocarpus chaplasha*	Sapwood and	Heartwood
White chuglam	*Terminalia bialata*	,,	,,
Kokko	*Albizzia lebbeck*	,,	,,
Kanju	*Holoptelea integrifolia*	,,	,,
Aini	*Artocarpus kirsuta*	,,	,,
Mundani	*Acrocarpus fraxinifoliuf*	,,	,,
Benteak	*Lagerstroemia lanceolata*	,,	,,
Chickrassy	*Chuckrasia tabularis*	Sapwood	—
Andaman padauk	*Pterocarpus dalbergiodes*	Sapwood	—
Champ	*Miohelia champaea*	Sapwood	—

Both the heartwood and the sapwood of all the above mentioned timbers were used in assessment except Chickrassy, Andaman padauk and Champ where only the sapwood was used, and in case of Benteak, only heartwood was used.

Preservatives

The preservatives[3] consist of mixtures of various inorganic and organic salts soluble in water, with the addition of a fixative salt, usually sodium dichromate or postassium dichromate. The effect of chromium is to fix the toxic element, arsenic, copper, zinc etc. in the wood so that the toxic salts become difficult to leach by the action of water. It is, however, necessary that the treated timber be allowed to dry for 3 to 6 weeks to complete the fixation process. These preservatives should be applied cold as they are liable to get precipitated when heated. The preservatives and their compositions used for the treatment of different timbers' blocks are as follows :

(*i*) *Copper-chrome-arsenic*:

Arsenic pentoxide	12·5 % by weight
Copper sulphate	37·5 do
Potassium dichromate or sodium dichromate	50 do

(*ii*) *Acid-cupric-chromate* :

Copper sulphate	50·0 % by weight
Potassium dichromate or sodium dichromate	45·0 do
Chromic acetate	5·0 do

(*iii*) *Copper-chrome-boric compositions* :

Boric acid	1·5 parts
Copper sulphate	3 do
Potassium dichromate	4 do

The solid preservative should contain at least 95 per cent of the above chemicals. The *p*H value of the solution ready for use should vary from 2·7 to 4·2 when determined by means of glass electrode at 15·5°C.

Method of Treatment

The test blocks of the timbers were treated with each preservative solution by 'hot and cold' bath process[4]. The process involves immersion of blocks of test timbers in boiling water for 15 minutes as described by Bhandari *et al*[2] and followed by immersion in cold solution of the preservatives for 30 minutes at room temperature. After treatment, the excess of liquor was drained off and the oven dry weight of the treated blocks were taken to determine the retention of the preservatives as used by Bhandari *et al*[2].

Test Organism

Polystictus sanguineus, (DRL (M), Kanpur culture No. 452) was used as test organism[5].

Preparations of Test Blocks

The method followed was the same as described in British Standard[6] No. 838(1961). From each type of timber cubic test blocks of size 1·875×1·875×1·875 cm with 3·125 mm central bore on the tangential plane were made. 'Feeder' blocks 3·5×2·0×0·2 cm were also made from the same test timbers. In all 42 blocks from each test timber were prepared. 12 blocks were treated with each of the three preservatives, while the remaining six were used as untreated control blocks in the mycological tests. Of the treated twelve blocks with each preservative, six were leached for evaluation of permanence of treatment. The other six were used as such *i.e.* in unleached condition.

LEACHING OF TREATED TEST BLOCKS

The treated test blocks were leached with running water in leaching apparatus continuously for 20 days[7]. After leaching, the test blocks were dried at room temperature (28°±2°C) for 48 hours before putting to test.

MYCOLOGICAL TEST PROCEDURE

The procedure as described by Findlay[8] was followed. 300 gms of garden soil (sandy-clay) seived through 25 mesh seive was filled in metallic screw-capped glass jars (16 cm×6 cm). Distilled water was added to bring the moisture content to 25 per cent. The soil jars were sterilized four times at 20 lb pressure for one hour on alternate days. Before the fourth sterilization, two 'feeder' blocks made of the same wood as that of the test blocks were placed on the soil surface side by side and a little apart without touching the sides of the glass jars. After final sterilization, the soil jars were inoculated with the test fungus *Polystictus sanguineus* from a fully grown (7 days old) culture. The inoculum was placed on the soil in between the two 'feeder' blocks. The jars were incubated at 30°± 2°C and after a period of 10 to 14 days when the fungus had fully grown and covered the feeder blocks, the test blocks after superficial sterilization by steaming for 30 minutes, were placed one on each 'feeder' block under aseptic conditions. The bore surface of the test blocks was kept juxtaposed the feeder blocks.

Twelve test blocks for each treatment (six leached and six unleached) were kept in pairs in each test jar. Untreated control test blocks were similarly placed in separate jars. Leached and unleached sets were also placed separately. The glass jars after placing the test blocks were sealed with strips of cotton fabric dipped in molten wax around the matallic screw caps so as to prevent loss of moisture during incubation period. The test jars were incubated for 4 months at 30°± 2°C.

At the end of the incubation period, the jars were opened and degree of fungal growth on test blocks visually recorded. Test blocks were then peeled of the fungal mat from the surface of the blocks and after oven drying at 60°C for 18 hours, the blocks were weighed to determine the loss in weight. Percentage loss was calculated according to the following formula[9].

$$\frac{(W-W1)}{W} \times 100$$

W—Initial oven dry weight before putting to test.

W1—Oven dry weight after test.

RESULTS AND DISCUSSIONS

The comparative efficacy and selective nature of the three preservatives both for sapwood and heartwood for different types of timbers under leached and unleached conditions are given in Table 2 and have been discussed below :

Sapwood

(*i*) There is no significant difference in all the three treatments in case of the unleached blocks of Chaplash and Kokko timbers. Similarly in case of leached blocks there is no significant difference in the treatment of A. padauk, Kokko, Chickrassy, Aini, Mundani, and Benteak timbers.

(*ii*) The treatment by copper-chrome-boric composition is best in case of Mango and Champ. Its effectiveness remains unchanged by leaching.

(*iii*) For unleached blocks the treatments by copper-chrome-arsenic and copper-chrome-boric compositions are equally good for White Chuglam and Jamun. In case of leached blocks, both the treatments mentioned above remain equally effective for White Chuglam but in case of Jamun the copper-chrome-arsenic composition turns out to be the best. Treatments with copper-chrome-arsenic and copper-chrome-boric compositions have turned out significantly better than acid-cupric-chromate composition in case of leached blocks of Chaplash whereas in unleached blocks of Chaplash there is no significant difference in the treatments.

(*iv*) In case of unleached blocks of Benteak and Kanju treatments with copper-chrome-arsenic and acid-cupric-chromate compositions are equally good and significantly better than treatment with copper-chrome-boric composition. But when leached blocks are used, there is no significant difference for Benteak, whereas, treatment with copper-chrome-arsenic composition has been found to be significantly better than the other two treatments in case of Kanju.

TABLE 2

MYCOLOGICAL TEST RESULTS

(based on wood soil culture technique) expressed as % loss in oven dry weight of the test blocks. Six replicates for leached, unleached and as control in each timber were used.

Timber (Common name)	Sapwood or Heartwood	Copper-chrome-arsenic composition		Acid-cupric-chromate composition		Copper-chrome-boric composition		Control
		Unleached	Leached	Unleached	Leached	Unleached	Leached	Untreated
1	2	3	4	5	6	7	8	9
1. White chuglam	Sapwood	5·4	6·1	15·3	16·7	7·6	8·4	46·98
	Heartwood	0·24	1·5	0·96	6·7	0·46	0·32	30·9
2. Mango	Sapwood	15·1	15·7	8·1	13·1	4·2	5·5	47·9
	Heartwood	5·3	5·5	7·8	19·8	7·4	8·5	43·58
3. Jamun	Sapwood	5·9	6·0	9·0	9·4	7·3	12·50	56·20
	Heartwood	1·3	1·4	3·8	4·1	2·1	11·2	51·40
4. Mundani	Sapwood	6·2	7·8	6·3	6·9	4·4	6·2	36·3
	Heartwood	1·7	1·6	2·02	3·8	2·2	2·9	9·8
5. Chaplash	Sapwood	3·7	5·5	6·5	10·3	4·3	5·7	46·4
	Heartwood	4·9	4·4	5·0	6·8	3·6	5·5	15·8
6. Aini	Sapwood	4·8	7·6	7·4	9·1	2·8	6·2	37·0
	Heartwood	4·0	9·9	3·4	4·1	3·8	5·56	26·7
7. Chickrassy	Sapwood	4·8	9·2	7·6	10·3	6·0	9·1	35·6
8. Jack	Heartwood	1·46	3·5	4·3	5·4	3·5	4·4	8·3
9. Kokko	Sapwood	8·4	9·9	8·6	9·3	5·9	10·73	37·7
	Heartwood	4.7	5·2	3·2	4·4	4·1	4·9	18·77
10. Kanju	Sapwood	3·6	3·8	5·4	11·4	18·6	19·4	69.6
	Heartwood	0·3	1·7	1·1	5·1	2·8	7·7	8·8
11. Benteak	Sapwood	0·0	1·19	0·01	3·2	4·0	2·29	12·3
	Heartwood	0·0	3·0	0.10	6·50	0·3	0·59	10·0
12. Champ	Sapwood	1·9	8·4	3·4	10·2	0·0	3·60	40·06
13. A. padauk	Sapwood	7·05	7.7	3·2	3·8	11·8	18·8	44·8

NOTE : Loss above 10% was taken as index for ineffectiveness of treatment against wood decay.

(*v*) Treatment with acid-cupric-chromate composition turns out to be the best in case of Andaman padauk timber under unleached condition. However under leached condition on the same timber, there is no significant difference in all the three treatments.

Heartwood

(*i*) For unleached blocks there is no significant difference between all the three treatments except in the case of Jack, Jamun and Chaplash. Treatment with copper-chrome-arsenic composition

has turned out to be the best for Jamun and Jack timbers whereas both copper-chrome-boric and copper-chrome-arsenic compositions have been found to be equally effective in case of Chaplash.

In case of leached blocks there is no significant difference in all the three treatments in case of Jack and Chaplash, whereas in case of Jamun treatments with copper-chrome-arsenic as well as acid-cupric-chromate compositions have been found to be equally effective and better than the treatment with copper-chrome-boric composition.

(*ii*) In case of leached blocks no significant difference has been noticed in all the three treatments in case of Aini, Jack, Chaplash and Kokko.

Treatments with copper-chrome-arsenic and copper-chrome-boric compositions have been found to be the best for Kanju and White Chuglam respectively. In case of Mundani and Mango, treatments with copper-chrome-arsenic and copper-chrome-boric compositions have been found equally effective and significantly better than acid-cupric-chromate treatment. For Benteak timber both copper-chrome-boric and acid-cupric-chromate treatments have been found equally effective and for Jamun treatments with acid-cupric-chromate and copper-chrome-arsenic compositions have been found equally effective.

CONCLUSION

In general, copper-chrome-arsenic treatment has been found to be superior in performance amongst the three water soluble preservatives. All the three preservatives have, however, been found satisfactory in respect of specific timbers. Sapwood has uniformlly shown greater susceptibility to decay than heartwood. There is no significant difference in all the three treatments in case of sapwood of A. padauk, Kokko, Chickrassy, Aini, Mundani and Benteak under leached condition. The copper-chrome-arsenic treatment has been found to be most suitable in case of Kanju and Jamun ; the copper-chrome-boric treatment has been found to be the best in case of Mango and Champ timbers whereas the treatments with copper-chrome-arsenic and copper-chrome-boric compositions have been found equally effective for White Chuglam under leached condition only. There is no significant difference for sapwood of Kokko and Chaplash under unleached condition. The copper-chrome-boric treatment has been found to be most effective in case of Mango, Champ and Mundani sapwood whereas the acid-cupric-chromate treatment was found to be the best for A. padauk under unleached conditions. The copper-chrome-arsenic and acid-cupric-chromate treatments have been found to be equally effective for White Chuglam, Jamun, Chickrassy and Aini. Treatments with copper-chrome-arsenic and acid-cupric-chromate have been found to be equally effective in case of Benteak and Kanju sapwood under unleached condition. For heartwood under unleached condition the copper-chrome-arsenic treatment has been found to be most effective for Jamun and Jack timbers, whereas copper-chrome-arsenic and copper-chrome-boric treatments have been found equally effective for the heartwood of Chaplash. However, there has been no significant difference for the heartwood of the remaining timbers in the unleached condition. In case of heartwood under leached condition copper-chrome-arsenic and copper-chrome-boric treatments have been found most effective for Kanju and White Chuglam respectively, copper-chrome-arsenic and copper-chrome-boric treatments have been found equally effective for Mundani and Mango whereas copper-chrome-boric and acid-cupric-chromate treatments are equally effective for Benteak heartwood and the treatments with acid-cupric-chromate and copper-chrome-arsenic compositions are equally effective for Jamun. No significant difference has been observed in case of heartwood of Aini, Jack, Chaplash and Kokko under leached condition.

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