PRESERVATION TREATMENT OF KEMPAS PILES TAKEN FROM SWAMP AND HILL FORESTS

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Received April 1991

SALAMAH SELAMAT & ANI SULAIMAN. 1992. **Preservation treatment of kempas piles taken from swamp and hill forests.** Preservative treatment of kempas piles taken from swampy and hilly regions was carried out on a preliminary basis. The preservative used was copper-chrome-arsenic and the samples were subjected to full cell process at 0 and 1 week drying time. Treated samples were analysed for their chemical absorption and dry salt retention. The swamp kempas absorbed a higher amount of copper-chrome-arsenic preservative solution than hill kempas. The increase in preservative loading after one week drying for the swamp and hill kempas was 33.2 and 21.2% respectively. The dry salt retention for hilly and swampy kempas was increased by 2.1 and 4.7% respectively. The percentage of area penetrated for swamp kempas was 80 to 100% and for hill kempas 59 to 61%. Swamp kempas showed a highly significant difference in fibre length, width, lumen and wall thickness from hill kempas. The pore diameter of swamp kempas was slightly smaller but the number of pores was greater. The number of rays per *mm* in the radial direction and the number of ray cells in swamp kempas were greater but the ray height and the number of seriate were less. The penetration of chemical in swamp kempas was higher due to the greater number of vessels and rays.

Key words: Kempas - CCA - full cell treatment - fibre morphology - wood structure

Introduction

Kempas is the standard Malaysian name for the timber *Koompassia malaccensis* which is commonly found in Malaysia. The trees, which can reach to a height of 55 *m* with 24 to 27 *m* of clear bole, and attain 6.5 *m* in girth (Foxworthy 1927), can be found in lowland forests and up to 600 *m* in altitude. The species is also found in peat and fresh water swamps.

Kempas is a timber commonly used for foundation piling in construction works, transmission poles and building constructions. It is considered a moderately durable timber with an average service life of 2.7 years (Mohd. Dahlan & Tam 1987). Its use in ground contact, particularly in foundation piling and transmission poles, therefore requires treatment with chemical preservatives. Kempas is widely selected for these purposes due to its amenability to preservative treatment. The current, widely used wood preservative or timber piles of kempas is water-borne copper-chrome-arsenic. Timber piles are normally pressure impregnated to ensure sufficient penetration. The accepted minimum dry salt retention based on the outermost 25 *mm* of the pile is 16 $kg\ m^{3}$ (SIRIM 1986).

Recently, there have been claims from sectors of the wood preservation industry that kempas collected from swamp, lowland forest is more difficult to treat than kempas from hilly regions. To investigate these claims the present study was carried out; the objective was to analyse the extent of chemical penetration and to determine dry salt retention in treated kempas timber piles from lowland (swamp) and hill forests.

Materials and methods

Sampling and treatment

Kempas samples were obtained from a private sawmill which had collected them from a lowland swamp forest at Kuala Langat, Selangor, and from a highland forest at Jengka, Pahang. Two sets of six sample replicates from each location, free from natural defects such as included phloem and knots, and measuring 15 × 15 × 120 *cm* were selected from timber piles selected by the sawmill. The first set was immediately subjected to full cell process using 12% weight/volume copper-chrome-arsenic preservative in accordance with Malaysian standard MS 733 (SIRIM 1981) and MS 360 (SIRIM 1986); this was considered as the 0 week drying time. The second set was given a similar treatment one week later after drying under shade and considered the 1 week drying time. The weight of each replicate was recorded before and after treatment. The treated samples were then left to air dry for one month under shade to ensure proper fixation of CCA in wood. For chemical analysis, sections were cut 5 *cm* from each end and at the centre of each timber pile. Chrome azurol-S reagent was used to measure the percentage of cross-sectional area of chemical penetration (SIRIM 1984). From each section, five different layers from the surface, each 1.8 *cm* thick, were cut and analysed for their dry salt retention. The chemical analysis carried out was in accordance with Malaysian standard MS 834 (SIRIM 1983a).

Fibre morphology and anatomical studies

For the study on fibre morphology and wood anatomy of kempas, the samples were taken from the remaining section not used for the preservative treatment. Fibres were prepared by macerating match stick-size samples with equal amounts of hydrogen peroxide and glacial acetic acid. Measurements were made on 50 fibres per sample. For anatomical studies, microtomed sections of about 20 μm thickness were mounted on glass slides stained with safranin and examined by light microscopy (Anonymous 1956). Measurements of fibres, rays and vessels were made on the Visopan under 40 times magnification.

Results and discussion

Chemical penetration

As shown in Table 1, the increase in preservative loading for the hill kempas after one week of drying time compared with 0 week drying was 21.2% and for the swamp kempas 33.2%. The increase in dry salt retention for hill kempas was 2.1% and 4.7% for swamp kempas. The value of dry salt retention in swamp kempas at 0 or 1 week drying time was already sufficient to fulfill the minimum requirement of Malaysian Standard MS 822 (SIRIM 1983b) for foundation piling which is 16 $kg\,m^{-3}$. In the case of the hill kempas, the values at both drying times did not fulfill the requirement set by the Malaysian standard. This is reflected by percentage of area penetrated, that is 80 to 100% for swamp, and 59 to 61% for hill kempas. Possibly longer drying time might be required to obtain higher absorption of chemical and dry salt retention. Even though the amounts of treatment solution absorbed by both sample types were high, the actual amount of salt retained determined by atomic absorption (AAS) was very much lower than the net dry salt retention. This suggested that although the solvent was easily absorbed by the wood, the active salt was not. As moisture content was reduced by about 4% after one week of drying, this could probably have induced loading of solvent more than the active salt. The reason could probably be due to the selective permeability of the cell wall membrane.

Table 1. The amount of chemical loading, the percentage of CCA penetration and CCA retention in kempas from two different localities

Sample type	Drying time (week)	Moisture content (% w/w)	Preservative loading ($kg\,m^{-3}$)	Net DSR ($kg\,m^{-3}$)	% of CCA penetration area*	DSR by AAS analysis**
Hilly kempas	0	31.3	113	13.6	59	13.7
	1	27.2	137	16.4	61	14.0
Swampy kempas	0	29.4	216	25.9	80	22.0
	1	25.0	288	34.6	100	23.0

* - Using chrome azurol - S reagent (SIRIM 1984)
** - Malaysian Standard (SIRIM 1983); DSR - Dry salt retention; CCA - copper-chrome-arsenic
AAS - Atomic absorption spectrophotometer

Mean amounts of individual salts in treated wood at different layers for swamp and hill kempas are shown in Figures 1 and 2, respectively. Statistical analysis using ANOVA at probability of 95% showed an interaction between sample type, drying time and sample layers (Table 2). Further analysis using Duncan's Multiple Range Test (DMRT) showed that swamp kempas can retain significantly higher content of copper, chromium and arsenic than hill kempas. One week of drying time under shade showed a significantly higher chemical retention in wood. The outermost layer is more highly significant in chemical retention than the inner layers, with retention decreasing greatly towards the core.

Table 2. Analysis of variance (ANOVA) for CCA treated kempas piles from two different localities

Dependent variable	Undependent' variable	DF	Anova SS	F value	Pr > f
$Cu_2SO_4.2H_2O$	SAM	1	120781	55.18	0.0001
	DT	1	68019	31.07	0.0001
	LAY	4	206337	23.57	0.0001
	SAM*DT	1	1316	0.60	0.0439
	SAM*LAY	4	3036	0.35	0.0846
	DT*LAY	4	10819	1.24	0.0297
	SAM*DT*LAY	4	11629	1.33	0.0260
$K_2Cr_2O_7$	SAM	1	162141	53.34	0.0001
	DT	1	82073	27.00	0.0001
	LAY	4	443389	36.47	0.0001
	SAM*DT	1	22979.	7.56	0.0065
	SAM*LAY	4	22573	1.86	0.0119
	DT*LAY	4	3256	0.27	0.0898
	SAM*DT*LAY	4	22309	1.83	0.0123
$As_2O_5.2H_2O$	SAM	1	34282	33.44	0.0001
	DT	1	16146	15.75	0.0001
	LAY	4	97823	23.86	0.0001
	SAM*DT	1	5823	5.68	0.0180
	SAM*LAY	4	7254	1.77	0.0136
	DT*LAY	4	1992	0.49	0.0746
	SAM*DT*LAY	4	8035	1.96	0.0101

Note: SAM - Sample types; DT - Drying time; LAY - Depth of penetration

Anatomical properties and fibre morphology

Using analysis of variance (ANOVA) at 5% probability level, swamp kempas showed a highly significant difference in all the four variables of fibre morphology observed (fibre length, width, lumen and wall thickness) in comparison to hill kempas (Table 3 & 4). However, in observing the wood anatomy, although pore diameter of swamp kempas was slightly smaller, the number of pores was greater (Table 5). Though rays are less in height in swamp kempas, they are greater in number.

The vessels of the kempas observed were not filled with tyloses or deposits (Figure 3) and thus would be considered free of any blockage for chemical movement. Since the number of vessels and rays in swamp kempas was greater, it is logical that the penetration of chemical was higher. Previous studies have shown that rays are responsible in providing the lateral flow of liquids in many hardwoods (Munmanis & Chudnoff 1979). It was also suggested that the direction of flow is from ray via vessel-ray pits to the vessels. Vessels in hardwoods have been known to assist in chemical penetration (Greaves 1974). Studies involving sapwood have been reported earlier in relating penetration of liquids (CCA) to anatomical structure and fibre morphology (Greaves 1974). Penetration into fibres was found to be extremely variable and unreliable due to the presence of pits and other

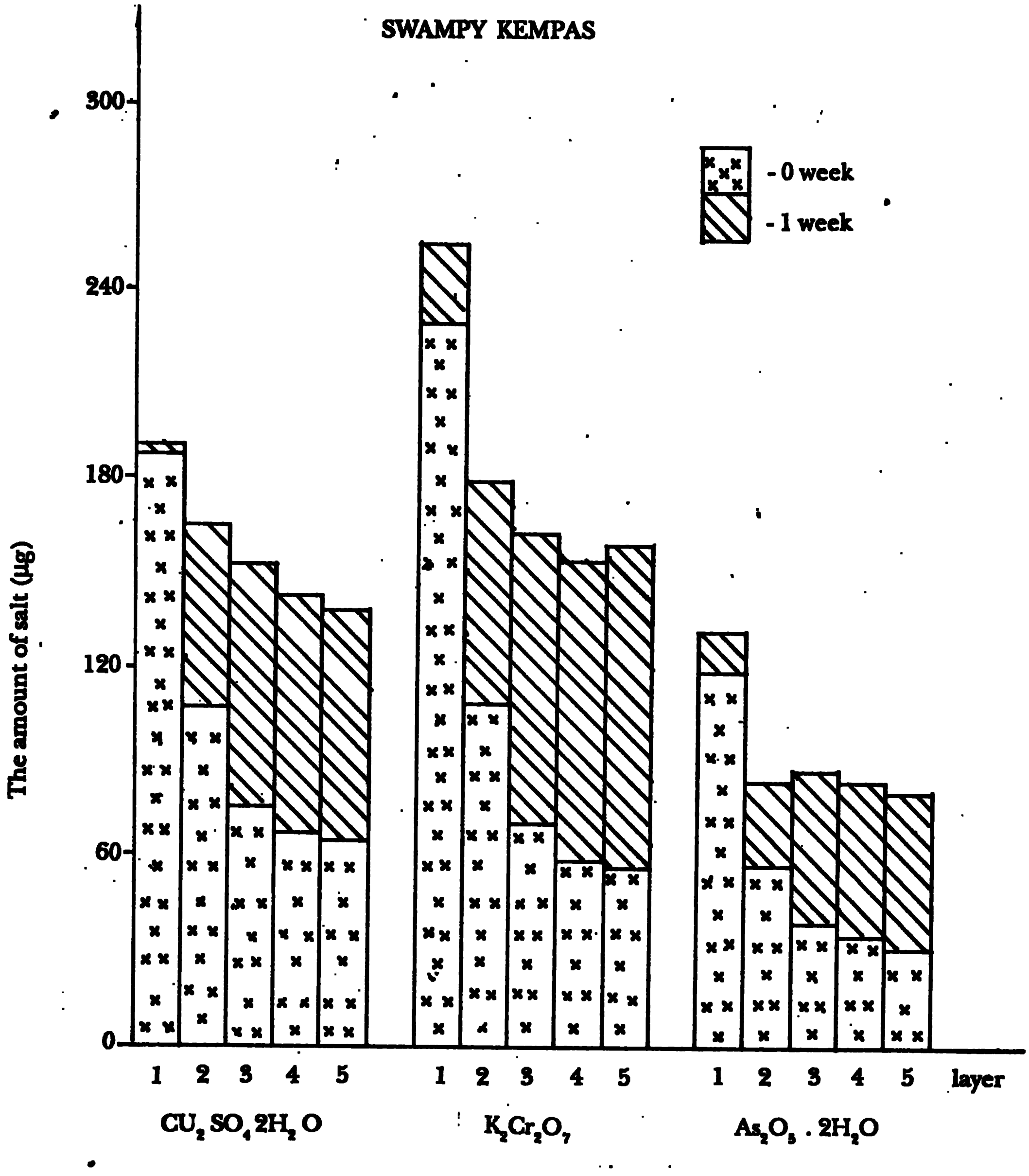

Figure 1. Mean amounts of salts in treated wood at different layers and different drying times

structures (Table 4). Thus, it may be considered that in the penetration of CCA in kempas, fibres may not play such a major role as vessels and rays in determining the extent of chemicals absorbed.

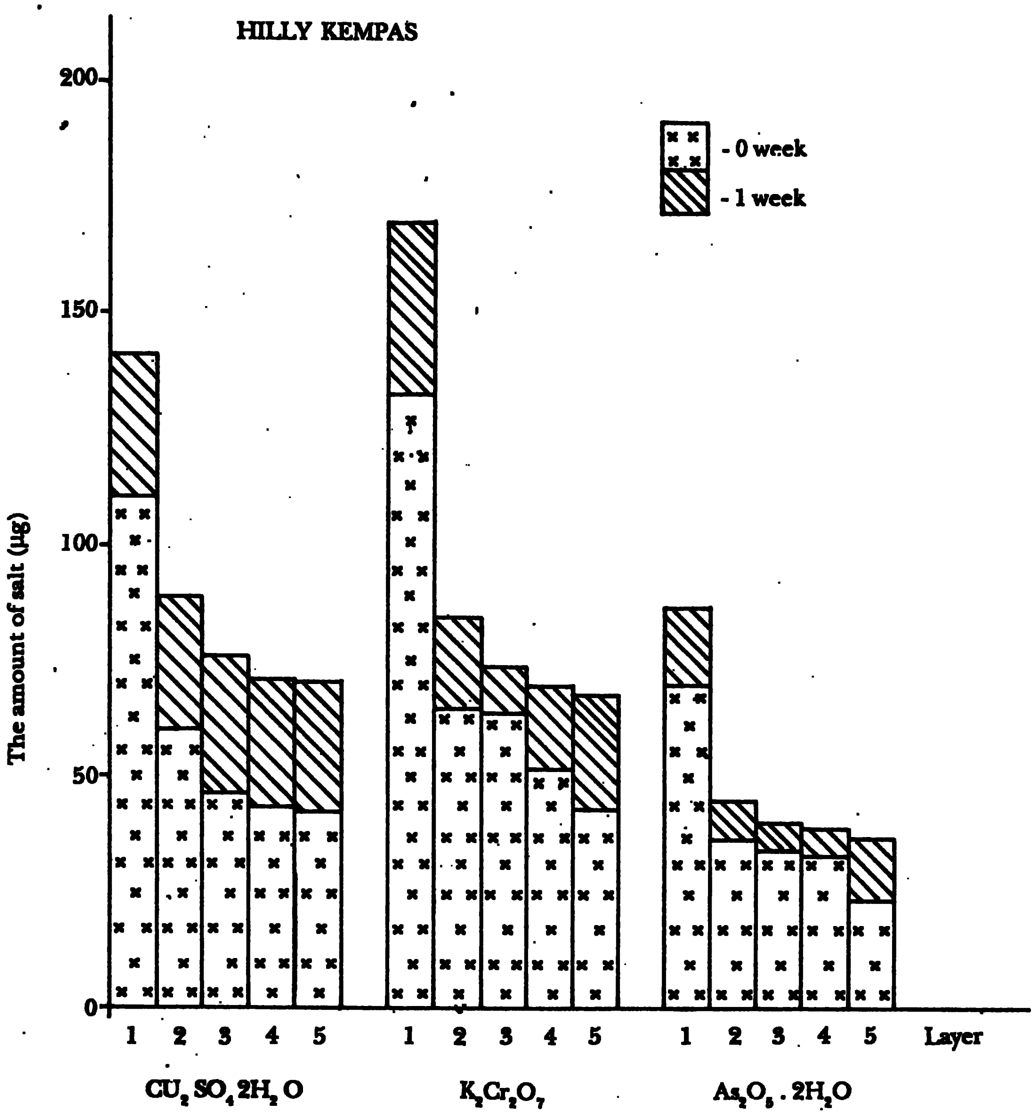

Figure 2. Mean amounts of salts in treated wood at different layers and different drying times

Table 3. Analysis of variance of four dependent variables of kempas from two different localities at 95% probability level

Dependent variable	Factors	DF	Anova SS	F value	Pr > F
Fibre length	Type	1	2.1	40.3	0.0001
Width of fibre	Type	1	1559	83.9	0.0001
Lumen	Type	1	392	29.3	0.0001
Wall thickness	Type	1	97	65.2	0.0001

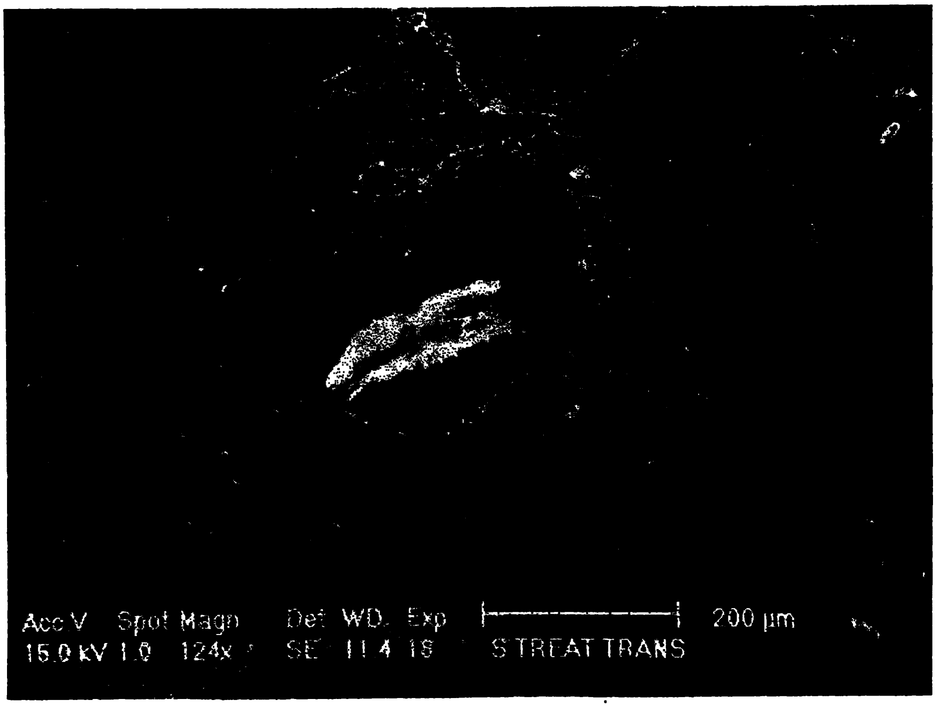

Figure 3. Cross section of a kempas vessel showing absence of tyloses or deposits

Table 4. Fibre dimensions of kempas from two different localities

Sample type	Fibre length (*mm*)	Fibre diameter (Width) (*µm*)	Lumen (*µm*)	Fibre wall thickness (*µm*)	Runkle's ratio
Swampy kempas	1.56	24.8	15.1	4.8	0.64
Hilly kempas	1.45	22.3	12.7	4.8	0.77

Table 5. Anatomical properties of kempas from two different localities

Sample type	Pore diameter (*µm*)	No. of pores (mm^{-2})	Ray			No. of rays mm^{-1}
			Height (*µm*)	No. of seriate (width)	Height (No.of cells)	
Swampy kempas	256	3.8	491	2.6	22	9.7
Hilly kempas	259	3.5	494	2.7	21	9.2

Conclusion

Swamp kempas was found to absorb and retain a significantly higher amount of chemical than hill kempas. This finding contradicts the claim made by operators in the timber preservation industry.

Acknowledgements

We would like to thank Zaiton Said and Hassan Mohd. Buang of the Wood Preservation and Analytical Section, and Mohd. Nadzri Yusoff and Normah Yahya of the Wood Anatomy Section for their technical assistance. Thanks are also due to K.C. Khoo for his invaluable comments on the manuscript.

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