FOREST INDUSTRY IN A DYNAMIC GLOBAL ENVIRONMENT

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INFLUENCE OF COMPOSITE MIX AND PARTICLE CONTENT ON THE STRENGTH AND SORPTION PROPERTIES OF *CALAMUS DEERRATUS* COMPOSITES

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Abstract
The influence of composite mix and particle content on the strength and sorption properties of *Calamus deerratus* composites was investigated. Experimental rattan cement boards were made from *C. deerratus* particles of 1.18 mm, cement: sand ratios of 1:2 and 1:3 and 5 and 10% rattan contents. Fabricated boards were tested after 28 days for strength and sorption properties. Results obtained showed that the strength properties reduced while the sorption properties increased with increase in rattan content and cement: sand ratio. The composites were however suitable for low stressed indoor and outdoor applications.

Keywords: Rattans, *Calamus deerratus*, Cement composites

Introduction

Rattans are important non-timber forest products after timber. They are trailing or climbing palms belonging to the family *Palmae* and sub-family *Lepidocaiyoideae* (scaly fruited palm). About 600 species of rattan and 13 genera are available worldwide while only 4 genera are endemic to Africa. These are *Laccosperma, Eremospatha, Calamus* and *Oncocalamus*. (Dransfield, 2001; Sunderland, 2001; Sunderland and Dransfield, 2002). *Calamus* is the largest rattan genus with about 370 species. *Calamus* is predominantly an Asian genus and ranges from the Indian subcontinent and south China southwards and east through the Malaysian region to Fiji, Vanuatu and tropical and subtropical parts of eastern Australia. In Africa, *Calamus* is represented by one species *Calamus deerratus* which exhibits high variability among populations. *C. deerratus* is particularly widely distributed and occurs from the Gambia, across to Kenya and Southwards to Zambia. The greatest concentration of rattan species along with the highest level of endemism occur in the Guineo-Congolian forest of Central Africa (Sunderland and Dransfield, 2002).

C. deerratus is distinct from all others because the cirri (i.e. the climbing organ which are long, thin with numerous re-curved hooks) arise from the stem. These rattan species are found in the rain-forest area near water-courses with stem ranging from 5 to 7 m long and 0.9 to 1.2 cm diameter. It possesses female inflorescences where the flowers are arranged in pairs comprising a fertile female and a sterile male flower. The male inflorescence has rows of solitary flowers. Canes obtained from this species are used for furniture and basketry works when *Eremospatha macrocarpa* canes are scarce (Morakinyo, 1993; Sunderland, 2002; Baker *et al*; 1999).

However, the sugar content of rattan canes makes them susceptible to insect and fungi attacks. Hence infested canes are unsuitable for cane works and are often discarded by on-site incineration. A viable means of enhancing complete material utilization of rattan canes is in the production of environmentally friendly cement-based composites. This work therefore examined the production and testing of cement bonded composites made from *Calamus deerratus* canes. The influence of composite mix and particle content was also investigated.

Materials and Methods

Matured stems of *C. deerratus* canes were harvested from Gambari Forest Reserve located in Ibadan, Oyo state, Nigeria. The canes were converted into billets of about 6 cm and hammer milled. The milled particles were sieved using a set of 2.34 mm, 1.18 mm and 0.85 mm sieves. Particles that passed through the 2.34 mm sieve and were retained in the 1.18 mm sieve were collected and dried to 10% moisture content. Experimental rattan-cement boards were made at the following production levels:

Cement: Sand: Rattan Ratio:	1: 2 and 1: 3
Rattan Particle Size:	1.18mm
Rattan content:	5 and 10%

Rattan-cement composites were made at the production levels stated above. De-ionised water was added at the rate of 0.25mL/g of cement + 2.7mL/g of rattan particles. The mixing procedure was done until homogenous slurry was obtained. The mixes were hand formed into a mat in a wooden deckle box placed on plastic caul plates in three replicates. The composites were de-moulded after 48 hours, placed in a conditioning room at a temperature of 20 ± 3°C and relative humidity of 65 ± 5% for another 28 days and then subjected to static bending and water resistance tests.

Results and Discussion

Moduli of Rupture (MOR) and Elasticity (MOE)

The MORs and MOEs of the composites were between 0.6 to 3.4 N/mm2 and 628.2 to 1098.3 N/mm² respectively (Table 1). The MORs and MOEs of the *Calamus* composites were comparable with those reported by Olorunnisola *et al*. (2005); Olorunnisola (2007) but were lower than those for Hardwoods (Badejo 1987; 1989; Fuwape and Oyagade, 1993). What this implies is that the *Calamus* composites cannot be used for structural purposes but as insulating components such as ceiling. As shown in Table 1, the MORs and MOEs of the *Calamus* composites decreases with increase in rattan and sand contents. This observation may be attributed to insufficient cement coating (Fabiyi, 2004; Olorunnisola, 2007) which may have resulted in poor bonding between the rattan particles and cement and hence loss of strength properties.

Statistical analyses revealed that rattan content significantly affected the MORs of the composites (Table 1)

Table 1: Moduli of Rupture and Elasticity of *Calamus* Composites

Rattan Content	Cement / Sand Ratio	Modulus of Rupture (N/mm²)	Modulus of Elasticity (N/mm²)
5%	1:2	3.4 A (0.2)	1055.0 A (434)
	1:3	2.0 AB (1.4)	628.2 A (9.3)
10%	1:2	0.7 B (0.4)	1098.3 A (691.4)
	1:3	0.6 B (0.4)	1093.6 A (1636.6)

*Means with the same letters are not statistically different. Standard Deviation in Parentheses

Water Absorption (WA) and Thickness Swelling (TS)

The WA and TS of the *Calamus* composites ranged between 10.2 to 16.6 % and 0.7 to 1.4 % after 2 hours and 11.0 to 18.1% and 1.5 to 2.5% after 24 hours immersion in water (Table 2). The *Calamus* composites were dimensionally stable having slow water absorption and

Table 2: Water Absorption and Thickness Swelling of *Calamus* Composites

Rattan Content	Cement / Sand Ratio	Water Absorption (%)		Thickness Swelling (%)	
		2 Hrs	24 Hr	2 Hrs	24 Hr
5%	1:2	10.2 B (0.09)	10.9 B (0.009)	0.7 B (0.8)	1.5 AB (1.1)
	1:3	11.3 B (0.07)	11.5 B (0.1)	0.9 B (0.6)	1.5 AB (1.1)
10%	1:2	16.4 A (0.6)	17.4 A (0.9)	1.2 AB (1.2)	1.7 AB (1.3)
	1:3	16.6 A (4.4)	18.1 A (3.5)	1.4 AB (1.1)	2.5 A (0.7)

*Means with the same letters are not statistically different. Standard Deviation in Parentheses thickness swelling rates comparable with those of Olorunnisola *et al.* (2005); Olorunnisola (2007) and hardwoods (Badejo 1987; 1989; Fuwape and Oyagade, 1993). Hence they are suitable for both indoor and outdoor applications. The WA and TS of the *Calamus* composites generally increased with increase in rattan and sand contents. This observation again may be attributable to poor bonding due to insufficient cement coating resulting in increased water uptake and thickness swelling. Statistical analyses revealed that while rattan content significantly influenced the water absorption of the *Calamus* composites, the thickness swelling was affected by the soaking time (Table 2).

Conclusions

The following can be deduced from this work:

i. The *Calamus deerratus* composites were suitable for non-structural applications for both indoor and outdoor purposes.

ii. The composites were dimensionally stable with low water absorption and thickness swelling rates.

iii. Increase in the rattan content caused significant reduction in the strength properties and increase in the water absorption.

References

Badejo, S.O.O. (1987). An investigation of the influence of cement binder content on the properties of cement-bonded particleboard from four tropical hardwoods. *Malaysian Forester* 50.1:107-120

Badejo, S.O.O. (1989). Influences of pre-treatment temperature and additive concentration on the properties of cement-bonded particleboard from plantation–grown tropical hardwoods. *Tropical Science*. 29: 285-296

Baker, W.J.; Dransfield, J; Harley, M.M. and Bruneau (1999). Morphology and cladistic analysis of sub-family *Calamoideae (Palmae)*. In: A Henderson and F. Borchsenius(eds.) Evolution, variation and classification of palms. *Memoirs of the New York Botanical Garden*. 83:307-324

Dransfield, J. (2001). "Taxonomy, biology and ecology of rattan". *Unasylva* 205, Vol. 52, F.A.O. Rome P 11 – 13.

Fabiyi, J.S. (2004). Effects of chemical additives concentrations on the strength and sorption properties of cement-bonded boards. *Journal of Tropical Forest Science* 16 (3) 6Pp

Fuwape, J.A. and Oyagade, A.O. (1993). Bending strength and dimensional stability of tropical wood-cement particleboard. *Bioresources Technology* 44: 77-79

Morakinyo, A.B. (1993). Herbarium Notes on species of rattan palm on exhibition at the herbarium of the Department of Botany, University of Ibadan (Unpublished).

Olorunnisola, A.O. Pitman, A. and Mansfield-William, H. (2005). Strength *Properties and potential uses of Rattan-Cement Composites. Journal of Bamboo and Rattan* 4.4: 343-352

Olorunnisola, A.O. (2007). Effects of particle geometry and chemical accelerator on strength properties of rattan–cement composites. *African Journal of Science and Technology (AJST) Science and Engineering Series* 8(1): 22 – 27

Sunderland, T.C.H. (2001), Rattan research and use in west and central Africa. *Unasylva* 205, Vol. 52. F.A.O., Rome, P. 18 – 26.

Sunderland, T.C.H. (2002). Status of Rattan Resources and Use in West and Central Africa. In. J. Dransfield, F.O. Tesoro and N. Manokaran eds. Non-Wood Forest Products 14. Rattan Current Research Issues and Prospects for Conservation and Sustainable Development. P. 77– 87. F.A.O., Rome.

Sunderland, T.C.H. and Dransfield, J. (2002). Species Profiles Rattans. (*Palmea: alamoideae*) In. J. Dransfield, F.O. Tesoro and N. Manokaran eds. Non-Wood Forest Products 14. Rattan urrent Research Issues and Prospects for Conservation and Sustainable Development. P. 9 – 22. F.A.O., Rome Sunderland and Dransfield, 2002