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STRENGTH AND SORPTION PROPERTIES OF PLASTIC COMPOSITES MADE FROM *EREMOSPATHA MACROCARPA* AND *LACCOSPERMA SECUNDIFLORUM* CANES

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ABSTRACT

The dwindling timber resource and the attendant shortage of wood supply call for alternative furnish for composite production. Rattan canes are candidate materials due to their availability, renewability and inexpensive processing cost. This work therefore examined the feasibility of using rattan canes as reinforcements for plastic composites production by evaluating the strength and sorption properties. Particles extracted from *Eremospatha macrocarpa* and *Laccosperma secundiflorum* canes harvested from wild stocks were milled into 0.4mm, dried to 0.5 % moisture content, blended with high density polyethylene (HDPE), talcum, Zinc stearate, Ethylene bistearamide (EBS) wax in the ratio 1.0: 0.82: 0.12: 0.04: 0.02 respectively and extruded using rotating twin-screw at barrel and die temperatures of between 149 and 193°C . The composites were cut to sample sizes and tested for flexural properties on a universal testing machine while sorption properties were evaluated after 2 and 24 hours immersion in water. The results obtained revealed that the respective moduli of rupture and elasticities of the *E. macrocarpa* and *L. secundiflorum* composites were 26.2 and 26.4 N/mm^2 and 2689 and 3406 N/mm^2 while the water absorption were between 1.2 to 3.1% and 1.0 to 2.4% and thickness swelling were 0.4 to 1.0 and 0.3 and 0.9% after 2 and 24 hours immersion in water. The study revealed that rattan canes were suitable as reinforcement for plastic composite production, dimensionally stable with low water absorption and thickness swelling rates and can be applied for both structural and non-structural interior and exterior purposes. Differences in the rattan anatomy influenced the ductility and sorption properties of the plastic composites.

INTRODUCTION

Wood serves as inexpensive fillers / reinforcement in plastic composite production imparting natural resistance to ultraviolet degradation. It increases melt or softening temperature of thermoplastic polymer and enhances the thermal stability, mechanical and machining properties. Some other components such as talcum, are added as property modifiers to improve stiffness and temperature resistance, Zinc stearate and/or Ethylene bistearamide (EBS) wax serve as lubricants and improve water resistance during plastic composites production (Woodhams *et al*., 1993). However, with the increasing demand for wood and wood products coupled with the over exploitation of wood in the forest and the attendant scarcity of timber supply, alternative furnish as reinforcement for composites production needs to be sought for. A candidate furnish for plastic composite production which is yet to be explored is rattan, a versatile climbing palm available in many forests in Nigeria.

Rattans are trailing or climbing palms that belong to the family *Palmae* and sub-family *Lepidocaiyoideae* (scaly fruited palm). Although there are about 600 species of rattan and 13 genera, only 4 are endemic to Africa namely *Laccosperma, Eremospatha, Calamus* and *Oncocalamus*. Two species, *Eremospatha macrocarpa* and *Lacosperma secundiflorum* are however mostly used in Nigeria for furniture and basketry works (Dransfield, 2001; Sunderland, 2001; Sunderland and Dransfield, 2002). One of the advantages of using rattan in composite production is that rattans have short rotation and can be harvested in less than seven years after planting and processed with simple and relatively cheap technology (Olorunnisola, 2005). Also, different rattan species exhibit different strength properties (Dahunsi, 2000; Lucas and Dahunsi, 2004) which may influence the properties of composite products. Therefore, it is imperative to investigate the influence of different rattan species in plastic composite production. Currently, there is no literature on the use of rattan canes as furnish for plastic composite production. Knowledge of the properties of rattan plastic composites obtained from this study will enhance the suitability of rattan canes as alternative furnish for plastic composite production. This work therefore investigated the strength and sorption properties of plastic composites made from two rattan species, *Eremospatha macrocarpa* and *Lacosperma secundiflorum*.

MATERIALS AND METHODS

Matured stems of *E. macrocarpa* and *L. secundiflorum* canes were harvested from Gambari Forest Reserve in Ibadan, Oyo state, Nigeria. The canes were converted into billets of about 4 cm and hammer milled, sieved into 0.4 mm particle size and oven dried at 100^{o}C to 0.5% moisture content. The particles were blended with high density polyethylene (HDPE), talcum, Zinc stearate, Ethylene bistearamide (EBS) wax in the ratio 1.0: 0.82: 0.12: 0.04: 0.02 respectively and fed into a rotating twin screw extruder at barrel and die temperatures of between 149 and 193°C; high enough to enhance melting of the HDPE but lower so as not to cause wood degradation. The extruded rattan composites were conditioned at 25^{0}C and 65 ± 5% relative humidity after production. Samples for flexural and sorption tests in three replicates were prepared in accordance with ASTM Standard D 790, 2008

Flexural Test

The flexural tests were conducted on a Universal Testing Machine at a cross – head speed of 1mm/min. The samples were loaded until failure occurred from which the Moduli of Rupture (MOR) and Elasticity (MOE) were evaluated.

Water Absorption (WA) and Thickness Swelling (TS) Test

The test samples were weighed and then immersed in distilled water at room temperature for 2 to 24 hours. At the end of 2 and 24 hours, each test samples were withdrawn from water and allowed to drain before the final weights and thicknesses were recorded. The water absorption and thickness swelling for each test piece was expressed as a percentage of the initial weights and thicknesses.

RESULTS AND DISCUSSION

Moduli of Rupture and Elasticity

The MORs are 26.2 and 26.3 N/mm^2 respectively for the *E. macrocarpa* and *L. secundiflorum* composites (Table 1). These values are comparable with those obtained by Migneault *et al*. (2008) and Schrip and Stender (2010) who recorded MOR values of 24 – 34 N/mm^2. Hence the rattan canes are suitable for plastic composites production. As shown in Table 1, no significant difference existed in the MORs of the rattan species. This may indicate that the species did not influence the MOR of the plastic composites.

The MOEs of the *E. macrocarpa* and *L. secundiflorum* composites were 2689 and 3406.3 N/mm^2 respectively. These values compared favourably with those of San *et al*., 2008 and Migneault *et al*. (2008) (2131 – 4279 N/mm^2) suggesting that the rattan particles are again suitable as reinforcement for plastic composites production. As shown in Table 1, the *L. secundiflorum* composites had significantly higher mean MOE value than those of *E. macrocarpa*. The differences in the MOEs of the rattan composites may be attributable to variation in anatomical structure. Dahunsi (2000) and Adefisan (2010) had noted presence of strengthening tissues in the *Laccosperma* canes as against storage tissues in the *Eremospatha* canes. This variation may account for the differences in MOEs obtained for the composites.

Table 1: Moduli of Rupture and Elasticity of Rattan-Plastic Composites

Species	MOR (N/mm^2)	MOE (N/mm^2)
E. macrocarpa	26.2^A (1.0)	2689.0^B (59.6)
L. secundiflorum	26.3^A (0.2)	3406.3^A (91.2)

Means with the same letters are not statistically different

Water Absorption (WA) and Thickness Swelling (TS)

The respective WA and TS of the rattan ranged between 1.0 to 1.2% and 0.4 to 0.6% after 2 h and between 2.4 to 3.1 % and 1.0 to 1.1% when soaked for 24 h in water Table 2. These values compared favourably with those of San *et al.* (2008), Migneault *et al.* (2008) and Schrip and Stender (2010). What this indicates is that rattan particles are again suitable for plastic composite production possessing equivalent dimensional stability as plastic composite made from wood and other lignocellulosic materials. As shown in Table 2, the rattan composites had low water absorption and thickness swelling rates suggesting that they are dimensionally stable. Therefore, the plastic composites can be used for both exterior and interior applications.

Generally, *E. macrocarpa* composites had more water uptake than those of *L. secundiflorum* composites (Table 2). What this suggests is that the *L. secundiflorum* composites were more dimensionally stable than those made from *E. macrocarpa*. Differences in the anatomical structures of the rattan species may again account for the variability in the water uptake.

Table 2: Water Absorption and Thickness Swelling of Rattan Composites

Soaking Time (Hours)	WA (%)	TS (%)
E. macrocarpa		
2	1.2^{C} (0.07)	0.4^{B} (0.1)
24	3.1^{A} (0.3)	1.0^{A} (0.3)
L. secundiflorum		
2	1.0^{C} (0.04)	0.6^{A} (0.05)
24	2.4^{B} (0.02)	1.1^{A} (0.03)

* Means with the same letters are not statistically different

CONCLUSION

The following conclusion can be drawn from this work:

i. Particles extracted from *Eremospatha macrocarpa* and *Lacosperma secundiflorum* canes are suitable for plastic composites production.

ii. The rattan plastic composites had adequate strength and dimensional stability comparable with those in literature.

iii. The rattan composites are suitable for both interior and exterior applications.

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