PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 27 (4) 691-695 April 2023

Water Absorption Characteristics of Two Rattan Species (*Laccosperma Secundiflorum* and *Eremospatha Macrocarpa*) from Fresh Water Swamp, Lagos State and Rain Forest, Edo State, Nigeria

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ABSTRACT: Water Absorption is one of the properties that determine the suitability of rattan canes as structural material especially for outdoor use. This study therefore evaluated the water absorption characteristics of two rattan species (*laccosperma secundiflorum* and *eremospatha macrocarpa*) from a fresh water swamp, Arapagi village, Lagos state and rain forest-Nicholas village, Edo state in Nigeria by collecting three matured wild rattan species from each ecological location and the water absorption carried out after 24 hours and 48 hours respectively. The results show that, water absorption after 24 hours ranged from 39.63 % to 82.51%. However, water absorption after 48hours increased from 44.53 % to 93.74 %. It was also observed that water absorption after 24 hours and 48 hours increased along the axial direction from base to top. Meanwhile, the samples of the two rattan species sourced from Rain forest had lower water absorption values than Fresh water swamp. In conclusion, the two rattan species had different levels of water affinity, however, samples obtained at the base from Rain forest absorbed less water.

DOI: **https://dx.doi.org/10.4314/jasem.v27i4.7**

Cite this paper as: OGUTUGA, S. O; OLAOYE, K. O; AREGHAN, S. E; OKANLAWON, F. B. (2023). Water Absorption Characteristics Of Two Rattan Species (*Laccosperma Secundiflorum* And *Eremospatha Macrocarpa*) From Fresh Water Swamp, Lagos State And Rain Forest, Edo State, Nigeria. *J. Appl. Sci. Environ. Manage.* 27 (4) 691-695

Dates: Received: 17 February 2023; Revised: 08 April 2023; Accepted: 16 April 2023
Published: 30 April 2023

Keywords: *Laccosperma secundiflorum; Eremospatha macrocarpa; ecological variation; water absorption*

Rattan has been identified as one of the multi-purpose plant resources found dominantly in tropical rainforest. It has a long, tough slender stems and has been opined as a potential material of economic importance in construction industry (Akpenpuun et al., 2017). Rattan has thirteen genera with over 600 species; four of these genera are endemic to Africa in the tropical rainforest regions. The species in Nigeria in descending order of availability are *Calamus deeratus*, *Eremospatha macrocarpa*, *Oncocalamus manni* and *Laccosperma secondiflorum*, having average stock densities per plot of 100 square metres of 6, 22, 12 and 18 clumps respectively. *Calamus deeratus* is the most abundant specie in Nigeria with small stemmed diameter ranging from 7.2 – 17.8mm (Obiukwu and Igboekwe, 2020). Wood, being the major forest product considered for construction is getting overwhelmed (Ogutuga et al., 2015; Aguda et al., 2020), thus giving rise to investigation into alternative forest products like bamboo, composites and Rattan species. Rattan cane has been demonstrated as a

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natural material having excellent potentials for furniture, craft products, and housing, hence its consideration as the only forest product seconded to timber and bamboo (Yang et al., 2020). However, as obtainable with other materials (wood, metal, brick etc.) found suitable for construction purposes, scientific tests and standards must be ensured before appropriate recommendations. Bhat and Mohan, (1991) opined that the physical properties of rattan are one of the most important indices required to determine the processing and utilization of rattan cane. The rate of water uptake of a material (such as wood) is an integer part of physical properties that generally signifies its water absorption capacity/resistance, and can influence the mechanical performance of the material when in service (Severa et al., 2003). As such, it is expected that similar trend be found with Rattan species. Okoh, (2014) stated that all strength properties of wood is reduced with percentage increase in water absorption, with modulus of rupture and compression parallel to grain decreasing by up to 4 to 6 percent respectively. Additionally, periodic water absorption has been found to have a negative effect on wood quality and increases the chance of microorganism attack on wood cell wall (Baronas and Ivanauskas, 2004).

In rattan composite materials, water presence inhibit mechanical properties (Steckel et al., 2007). Ebewele, (2001) highlighted poor resistance to moisture as one of the important factors bedevilling the proper and effective harnessing and utilization of composites made of lignocellulosic fibres. Fibrous materials having low resistance to water absorption have undesirable effects on mechanical properties and dimensional stability of its composites (Stamboulis et al., 2000; Kajaks et al., 2001; Mohd Ishak et al., 2001; Joseph et al., 2002; Lin et al., 2002; Tajvidi and Ebrahimi, 2003; Manaia and Manaia, 2021). Species and stem position have been identified has some of the important factors influencing physico-mechanical properties of rattan (Bhat and Mohan, 1991). Consequently, rattan species being a fibrous material needed to be investigated for its water absorption capacity to ensure a desirable mechanical trait and dimensional stability.

This will aid its potential usage for structural purposes. However, information on interplay among species, cane position and location on water absorption properties of Nigerian rattan species is limited. Therefore, this study investigated the water absorption characteristics of two rattan species (*laccosperma secundiflorum* and *eremospatha macrocarpa*) from a fresh water swamp, Arapagi village, Lagos state and rain forest- Nicholas village, Edo state in Nigeria.

MATERIALS AND METHODS

Three matured wild *L. secundiflorum* and *E. macrocarpa* were obtained each from Fresh water swamp- Arapagi Village, Ibeju-Lekki Local Government Area, Lagos State and Rain forest-Nicholas Village, Ovia North-East Local Government Area, Edo State. The rattan samples were carefully collected and their morphological characteristics were studied for the purpose of proper identification with references made to the stocks of rattan samples kept in the Herbarium of the Department of Forest Conservation and Protection, Forestry Research Institute of Nigeria, Ibadan, Oyo State, Nigeria. The samples were collected along the sampling height for base, middle and top.

Preparation and Testing of Samples: Samples for water absorption test after 24 hours and 48 hours (60 mm long) were collected from the base, middle and top of each of the two rattan species stems of the two ecological zones following ASTM D143-52 (ASTM, 1972) with modification due to the peculiarities of rattan species. Each treatment combination was replicated five times and 60 samples were obtained for each of the variables tested. The method used for the determination of water absorption test after 24 hours and 48 hours for the two rattan species from the two ecological zones is in accordance with ASTM D1037-94 (ASTM, 1994).

Experimental Design: The experiment was laid in a Completely Randomized Design (CRD) in 2 x 2 x 3 factorial with five replicates.

Data Analysis: Data were analysed using Analysis of variance (ANOVA) at 0.05 level of probability with SPSS Statistics version 20.0 to determine if the rattan species, rattan location and sampling height had significant effects on the water absorption of the rattan species. Duncan Multiple Range Test (Duncan, 1955) was used to separate or compare means of significance among treatments at 5% probability level.

RESULTS AND DISCUSSION

The result for water absorption after 24 hours and 48 hours of rattan species samples of the two different ecological zones are presented in Figure 1. After 24 hours, water absorption of *L. secundiflorum* was higher (73.69 %) in Fresh water swamp than in Rain forest (69.58 %), and a similar trend was observed with *E. macrocarpa* where water absorption was higher (54.75 %) in Fresh water than in Rain forest (47.15 %). Mean value of water absorption obtained at the top (72.61 %) was higher than the mean water absorption obtained at middle (56.95 %) and at base (54.32 %) regardless of the species' locations.

After 48 hours, *L. Secundiflorum* had higher water absorption (86.73 %) in Fresh water swamp, and (82.81 %) in Rain forest than *E. macrocarpa* (65.04 %) in Fresh water swamp and (54.57 %) in Rain forest. Rattan species samples obtained at the top portion had a mean water absorption of 85.42 % which was also different from the mean water absorption obtained at the middle (67.48 %) and base portion (63.97 %) (Figure 1). Meanwhile, the water absorption percentage recorded by Olorunnisola and Agrawal (2018) for rattan cane fibre of *L. secundiflorum* was 365.8% at 24 hours.

It may thus imply that when rattan cane is difibrated, it's affinity for water increases. Evidently, *L. Secundiflorum* had a higher water absorption which was an indication that it has a higher affinity for water uptake than *E. macrocarpa*. This therefore implies that *L. secundiflorum* had a poorer water resistance. This agreed with the report of Ebewele (2001), who stated that, poor water resistance inhibits proper utilization of lignocellulosic fibrous materials. However, Adefisan et al., (2017) and Adefisan (2019) found a different trend when using these rattan species for composite materials. Adefisan et al., (2017) recorded lower water absorption percentages of 2.2% and 7.9% for *L. secundiflorum,* and 5.4% and 20.8% for *E. Macrocarpa* at 1day and 61days respectively, while Adefisan (2019) recorded 2.1% and 2.4% for *L. secundiflorum,* and 5.4% and 8.1 for *E. macrocarpa* at 24hrs and 48hrs respectively.

Notwithstanding, high water absorption has been found to negatively affect quality, and increase microorganism attack in wood as also reiterated by Baronas and Ivanauskas, (2004), which can in turn influence mechanical performance in service. An akin event could be expected for rattan species. Meanwhile, it could be observed from the result that, an initiate higher water uptake was exhibited by the two rattan species for the first 24hours, followed by a slower absorption rate after 48hours. This particular pattern is common for wood, and it is called the relaxation phase as reported by Kumar and Flynn, (2006). It suggests a two-step process, in which more than half of the final absorbed water occurred in the first two days of liquid water contact with the wood was a suggestion of possibility by Khazaei, (2008).

In the course of this study, more than half of the final absorbed water occurred for *L. Secundiflorum* and *E. macrocarpa* in the first day (24hours).

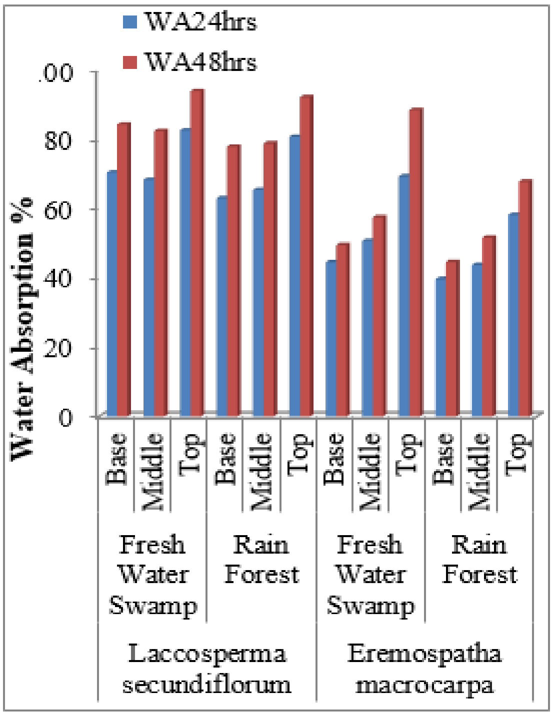

Fig 1: Water absorption (%) of rattan species from different ecological locations

As explained by Khazaei (2008)), a condition which necessitated an initial high water absorption in wood could be attributed to diffusion phenomenon - a process which permits fluid to migrate and spread through capillaries, vessels and cellular walls of a wood. Hence, moisture diffusion into the wood takes place because of the moisture gradient between the surface and the centre. As sorption proceeds, the water content increases, causing the driving force to diminish, as well as the absorption rate. A similarly occurrence as with wood could therefore be suspected to have occurred in this study for rattan species, thus causing a higher initial water absorption rate after 24 hours.

A higher water absorption of rattan species obtained in Fresh swamp could be attributed to the lower rate of growth in Fresh water swamp than Rain forest leading to the formation of thin cell wall and high cell lumen hence, making the rattan species samples obtained from Fresh water swamp absorb more water. Base rattan with the lowest water absorption is considered more suitable than middle and top rattan thus, having a better water resistance. It is expected that the better resistance to water absorption will make it more appropriate for mechanical purposes. Also, a lower water absorption obtained at the base of the rattan species might be as a result of the proportion of mature to juvenile rattan which is high at the base, hence making it more resistible to water uptake. A significant difference observed for water absorption among base, middle and top rattan is an indication that base rattan will perform significantly better when used where a good water resistance is required, such as with outdoors functions. There is significant difference in water absorption after 24hours and 48hours among the rattan species and along the sampling height (Table 1) at $p<0.05$ while, rattan location and their level of interaction had no significant effect on water absorption. The follow up test as presented in Table 2 showed that rattan species and sampling height were different from one another with *E. macrocarpa* and samples from the base having a better water resistance.

Table 1: Analysis of variance for water absorption after 24 hours and 48 hours

		F-cal			
Source of Variation	**df**	**WA 24hrs Sig.**	**WA 24hrs**	**WA 48hrs Sig.**	**WA 48hrs**
Rattan Species	1	0.000*	19.379	0.001*	25.283
Rattan Location	1	0.219^{ns}	1.552	0.154^{ns}	2.099
Sampling Height	2	0.005*	5.906	0.002*	7.163
Rattan Species * Rattan Location	1	0.713^{ns}	0.137	0.512^{ns}	0.436
Rattan Species * Sampling Height	2	0.834^{ns}	0.182	0.297^{ns}	1.246
Rattan Location * Sampling Height	2	0.991^{ns}	0.009	0.848^{ns}	0.166
Rattan Species * Rattan Location * Sampling Height	2	0.878^{ns}	0.131	0.673^{ns}	0.399
Error	48				
Total	59				

*Sig.: Significance, WA: Water Absorption, hrs: hours, * Significant at p<0.05 and ns= not significant at p>0.05*

Table 2: Follow-up test for rattan species and sampling height

Variables	**WA 24hrs Mean±SDV**	**WA 48hrs Mean±SDV**
Sampling Height	54.32^{b}±17.65	63.97^{b}±20.42
Base	56.94^{b}±19.22	67.48^{b}±22.58
Middle	72.61^{a}±23.11	85.42^{a}±24.87
Top		
Rattan Species		
L. secundiflorum	71.63^{a}±22.02	84.77^{a}±22.24
E. macrocarpa	50.95^{b}±14.99	59.81^{b}±19.44

Mean with the same superscript in the same column are not significantly different (p<0.05) from one another

Conclusion: Water absorption test of selected rattan species from two different ecological locations revealed that *L. secundiflorum* and *E. macrocarpa* rattan species have different water affinity, and a significant difference in water absorption of the rattan species existed along the sampling height. It was also noted that rattan species obtained from Rain forest absorbed less water compared to those obtained from Fresh water swamp.

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