VARIATION OF PHYSICAL AND MECHANICAL PROPERTIES OF *CALAMUS ERECTUS*

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ABSTRACT

The physical characteristics, physical and mechanical properties of *Calamus erectus* have been studied at three height positions. The variation of physical properties due to node and internode have also been investigated. The moisture content and shrinkage increase, whereas the specific gravity decreases with the height of the stem. The specific gravity is higher at the node than that at the internode. The bottom portion is stronger in respect of compressive strength, bending strength, nail withdrawal and side hardness.

সারসংক্ষেপ

তিনটি ভিন্ন উচ্চতায় ক্যালামাস ইরেকটাস প্রজাতির বেতের বাহ্যিক বৈশিষ্ট, ভৌত ও শক্তি সম্বন্ধীয় গুণাবলী পরীক্ষা করা হয়েছে। পর্ব ও পর্বমধ্যের জন্য ভৌত ধর্মের পরিবর্তনও দেখা হয়েছে। উচ্চতা বৃদ্ধির সাথে সাথে বেতের জলীয় অংশ ও সংকোচন বৃদ্ধি পায় অপর পক্ষে আপেক্ষিক গুরুত্ব হ্রাস পায়। পর্বের আপেক্ষিক গুরুত্ব পর্বমধ্যে অপেক্ষা বেশী পরিলক্ষিত হয়। বেতের গোড়ার অংশের আঁশ বরাবর চাপশক্তি, বক্রতার শক্তি, পেরেক ধারণ ক্ষমতা ও পার্শ্ব কাঠিন্যের সাপেক্ষে উচ্চ শক্তি প্রদর্শন করে।

INTRODUCTION

Rattan is one of the important non-wood forest products extensively used in the cottage industry. Since the last decade, the demand for the rattan furniture has been increasing tremendously. There are 13 genera of rattan in the world of which only two, *Calamus* and *Daemonorops*, are available in Bangladesh (Alam 1990). The use of each species of rattan is selected by its physical characteristics, such as diameter, length, etc. The large diameter rattan is used for frame work, while the small diameter species are used for weaving and as a binding material.

Information on the physical and mechanical properties of rattan are essential for its proper utilization. No such information of rattan is available in Bangladesh except on *Daemonorops jenkinsiana* (Kabir *et al.* 1993). The cottage industry is however run traditionally with a limited number of species. The present study aims at evaluating the properties of *Calamus erectus* which is the largest diameter rattan in Bangladesh.

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MATERIALS AND METHODS

The stems of mature *Calamus erectus* were collected from the forest of Sitakunda hill of Chittagong. The maturity of the stem were determined by loosening of the leaf sheath and exposed stem at the lower portion of the stem. Three rattan stems were taken for this study and each stem was divided into three equal portions - bottom, middle and top. Three samples were taken for the physical properties from the middle of the internode and the consecutive node of each portion. Two specimens were taken from each portion for mechanical properties, one for test in green condition and the other for test in airdry condition. The length of the specimens for compressive test was of four times of the average diameter. The static bending test was carried out according to the ASTM standard (Anon 1971) with a minor modification. The hardness and nail withdrawal was determined at the side of the stem in green and airdry conditions.

RESULTS AND DISCUSSION

The physical characteristics, such as stem length, number of internode per stem, internode length and internode diameter of *Calamus erectus* are presented in Table 1. The stem length of this species was found to be 2.99 m with 35.3 internodes per stem. The internode length varied from 4.50 cm to 11.5 cm, the longer internode being at the bottom.

The stem diameter is an important criterion in determing the end uses. *Calamus erectus* is the largest diameter rattan in Bangladesh with its dimension ranging from 4.2 cm to 8.15 cm. The bottom was found to exhibit the highest diameter. The species falls under the large diameter rattan according to the classification of Bhatt and Renuka (1986), as it has the diameter more than 18 mm. The diameter decreased sharply from the bottom to middle and more or less remained same towards the top. The internode length decreased considerably from the bottom to the top. Similar trend was also observed by Renuka *et al.* (1987) for other *Calamaus* species in India. Compared to other large diameter rattan like *Daemonorops jenkinsiana Calamus erectus* is shorter in stem and internode length (Kabir *et al.* 1993).

The physical properties, viz., moisture content, specific gravity and volumetric shrinkage of internode and node at three height levels are presented in Table 2. The moisture content was found to decrease from the bottom to the top. The internode showed a higher moisture content than that at the node. Regardless of the height and the nodal position, the specific gravity ranged from 0.339 to 0.505 and from 0.518 to 0.709 based in green and ovendry volumes respectively. The specific gravity decreased along the stem height. This agrees with the previous observations made by Renuka *et al.* (1987), Bhat and Renuka (1986), Kabir *et al.* (1993). The specific gravity of this species was higher than that of *Daemonorops jenkinsiana* (Kabir *et al.* 1993). As the rattan stem dried, the specific gravity increased and thus the ovendry specific gravity exhibited a higher value than in the green condition. The similar results were also observed for *Deamonorops jenkinsiana* (Kabir *et al.* 1993). However, contrary to this trend, Ismail *et al.* (1982) and Goh (1982) noted a lower value in the ovendry condition. The nodes were observed to possess a higher specific gravity than the internode. This may be related to a lower moisture content of the node. A strong negative correlation was found between the moisture content and the specific gravity (Table 4). The height of the stem showed an inverse effect on both the volumetric and diameter shrinkage (Table 2). The highest shrinkage values were obtained at the top portion. Table 4 shows that there was a strong positive correlation between the moisture content and the volumetric shrinkage.

The mechanical properties, such as compressive strength parallel to grain, modulus of elasticity, modulus of rupture, nail withdrawal and side hardness in green and airdry conditions are shown in Table 3. The height affected inversely all these

Table 1. Physical characteristics of *Calamus erectus*

Length of the culm (m) (range)	No. of internode per culm (range)	Internode length (cm) (range)			Internode diameter (cm) (range)		
		bottom	middle	top	bottom	middle	top
2.99 (2.66-3.30)	35.3 (32-38)	8.9 (6.5-11.2)	8.4 (6.2-11.5)	6.1 (4.5-8.2)	5.2 (4.6-8.2)	4.9 (4.3-5.7)	4.9 (4.2-5.5)

Table 2. Physical properties of *Calamus erectus*

Height position	Moisture content (%)		Specific gravity on ovendry weight and				Volumetric shrinkage (%)		Diameter shrinkage (%)	
			green volume		ovendry volume					
	internode	node	internode	node	internode	node	internode	node	internode	node
bottom	134	123	0.474	0.505	0.690	0.709	32.9	23.9	2.12	1.87
middle	145	136	0.459	0.475	0.650	0.701	34.5	26.8	2.53	2.95
top	215	180	0.339	0.393	0.518	0.547	43.6	28.0	2.88	3.23

Table 3. Mechanical properties of *Calamus erectus*

Height position	Compressive strength kg/cm²		Static bending				Nail withdrawal kg		Side hardness kg	
			Modulus of elasticity 1000 kg/cm²		Modulus of rupture kg/cm²					
	green	airdry	green	airdry	green	airdry	green	airdry	green	airdry
bottom	196	204	44.4	35.0	601	517	54	80	380	582
middle	169	101	39.4	24.4	596	408	51	29	324	203
top	108	140	21.6	21.1	371	416	44	23	285	177

Table 4. Correlation coefficient of the physical and mechanical properties of *Calamus erectus*

Physical properties	Moisture content	Specific gravity	Volumetric shrinkage	Compressive strength	Modulus of elasticity	Modulus of rupture
Moisture content	1.000	-0.974**	+0.489**	-0.681 ns	-0.746 ns	-0.813*
Specific gravity		1.000	-0.414 ns	+0.681 ns	+0.513 ns	+0.838 **
volumetric shrinkage			1.000	-0.344 ns	-0.344 ns	-0.201 ns

ns - not significant
* - Significant at 5% level of probability
** - significant at 1% level of probability

mechanical properties. The bottom portion were found stronger in respect of the strength properties. The compression test showed that the airdried stems were characterized with a higher crushing strength (Table 3). The higher crushing strength in airdry condition were also noted by Goh (1982) and Ismail *et al.* (1987). The other strength properties showed no definite trend in the airdry condition. The moisture content and volumetric shrinkage correlated negatively to the mechanical properties, while specific gravity was positively related. The correlation is found significant only for modulus of rupture (Table 4).

CONCLUSION

The internode length and diameter of *Calamus erectus* decreased along the culm height. The bottom portion had a lower moisture content, volumetric shrinkage and diameter shrinkage with a higher specific gravity. The specific gravity was higher at the node than that at the internode. The maximum strengths were observed in the bottom of the stem. The species is suitable for use as framing of the furniture requiring larger diameter and higher strength.

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