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Assessment of some physical and mechanical properties of Golla bet (*Daemonorops jenkinsiana)* from north-eastern region of Bangladesh

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Abstract—The physical and mechanical properties of Golla bet (*Daemonorops jenkinsiana*) from the north-eastern part of Bangladesh were investigated. These properties were studied in three height positions (bottom, middle and top) of three age groups (3, 4 and 5 years old). The variation of these properties due to node and internode has also been determined. Moisture content, volumetric shrinkage and basic density were evaluated from green to oven-dry condition, compressive strength, MOE and MOR were evaluated from green to air-dry condition. The moisture content increased gradually from the bottom to top. The density, compressive strength and bending strength decreased along the culm height from the bottom to the top. It was found that the node and internode had no significant effect on those properties. Effect of age was significant in all cases, except for moisture content and compressive strength. The effect of height was significant in all cases. Golla bet of the 5 years age group showed higher physical and mechanical properties except moisture content and shrinkage and the 3 years age group showed higher moisture content and shrinkage values. Negative correlation was found for physical properties with compressive strength.

Key words: Moisture content; shrinkage; density; compressive strength; MOE; MOR.

INTRODUCTION

Cane is an important non-timber forest product in Bangladesh and has received more attention than all other non-timber forest products due to its important economic value. It is a climbing palm belonging to the Calamoideae, a large subfamily of Palmae or Arecaceae [1], and is extensively used in the cane-based cottage industries. There are 13 genera of cane in the world of which only two, *Calamus* and *Daemonorops*, are available in Bangladesh. *Calamus* is represented by 10 species and *Daemonorops* by a single species, *Daemonorops jenkinsiana*, locally known as

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Golla bet. This is widely planted in forests and also in village groves [2]. For this reason the extracted cane needs to be studied to assess the potentiality of the species for various end-uses. The average specific gravity of Golla bet ranges from 0.41 to 0.48 in the nodal position and 0.40 to 0.46 in the internodal position [3].

Locally Golla bet is used in cottage industries for furniture and rope [4–6]. Information regarding physical and mechanical properties is required for better utilization of the material. Limited works has been conducted on this aspect. In India the morphological, anatomical and physical properties of 10 *Calamus* species were studied [7]. The physical and mechanical properties of some C*alamus* species of Malaysia have also been evaluated [8–10]. In Indonesia, the anatomical and strength properties of three *Calamus* species have been studied [11]. However, to date no one has paid attention to the assessment of physical and mechanical properties of *Daemonorops jenkinsiana* in the north-eastern part (Sylhet region) of Bangladesh. As a result people still depend on their traditional knowledge, which may lead to improper utilization of cane. Therefore, this study is aimed at evaluating the physical and mechanical properties of Golla bet cane of this region for its proper utilization as a raw material in cottage industries.

MATERIALS AND METHODS

Study area

Samples were collected from the Juri Range Cane Plantation of Sylhet Forest Division, Bangladesh. The area is situated between 23°55′ and 25°02′ North latitude and between 90°55′ and 92°30′ East longitude. The division is bounded by Khasia Jointa Hills on the North, Assam and Tripura of India and composed of valley, hills and plain lands. The soils of the area are sandy to clayey loam and the area has moist tropical climate characterized by a period of high precipitation from April to September and five months of relatively dry period from November to March. With minor variations, humidity remains high at 70% to 85% throughout the year [12].

Sample preparation and testing

Six representative canes of each age group (3, 4 and 5 years old) were selected for each test of physical properties, and samples were collected from bottom, middle and top portions of each cane. Moisture content was measured using the oven-dry method. Shrinkage was evaluated as percentage of dimensional changes from green condition to oven-dry condition. For each test, oven-dry dimension measurements were taken after the specimens were placed in the oven with constant temperature (103 ± 2°C) for 24 h. Basic density was determined from specimens based on green volume and oven-dry weight. The volume measurements were done using the water displacement method.

Two bundles of sticks (each containing six canes) were prepared for each test of mechanical properties and samples were collected from three height positions

(bottom, middle and top) of each cane of each age group (3, 4 and 5 years old). One bundle of sticks was kept in green condition and the other bundle was air-dried for each test of mechanical properties. Mechanical properties were evaluated in accordance with the specification of American Standards of Testing Materials (ASTM) [13] with minor modification. For compressive strength the length of specimens was four times the average diameter. Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) were determined by loading at the node and in between the node.

Statistical analysis

Analysis of Variance (ANOVA) was done followed by Factorial Experiment to determine the effect of age, height, node and internodes on physical and mechanical properties. Correlation was employed to determine the relationship between physical properties with mechanical properties.

RESULTS AND DISCUSSION

The physical characteristics, such as internode length and diameter are presented in Table 1. The stem diameter is an important criterion in determining the end-uses. The mean internode length and diameter of the middle portion were found slightly lower than those of bottom and top portions (Table 1). The same opinion was also reported by Kabir *et al*. [6]. According to the classification of Ref. [7], the species belongs to the large diameter classes, as it had a diameter above 18 mm. Other investigators concluded that the diameter decreased gradually from bottom to top and internode length increased from bottom to middle then decreased slowly towards the top for Malaysian cane [8].

The moisture content, basic density and volumetric shrinkage are shown in Table 2. These properties are important since they influence physical and mechanical properties. For example, the relative amount of water in cane affects weight, decay susceptibility, permeability, strength and dimensional stability.

The location along the culm height affected the amount of moisture content significantly and the top was found to have the highest value (Table 3). In nodes the average moisture content was 171% and in internodes 201%. The variation of moisture content due to age, node and internode was insignificant but variation due to height was significant (Table 4). In nodes the average density was found to

Table 1.
Physical characteristics of Golla cane

Height position	Mean internode length (cm)	Mean diameter (mm)
Bottom	24.6	27.8
Middle	21.3	25.2
Top	22.4	26.2

be 0.37 gm/cm^3 and in internodes 0.35 g/cm^3 (Table 2). The effect of node and internode was found insignificant for density. As the height increased the density decreased significantly. The effect of age was also significant for density (Table 4). This is also supported by the findings of Goh [9]. The total volumetric shrinkage increased as the height increases from bottom to top (Table 2). In nodes the average shrinkage value was 24.5% and in internode shrinkage it was 30.6% from green to oven-dry condition. Effect of age and height were significant on shrinkage but the effect of node and internode were insignificant (Table 4). A similar conclusion was drawn by Goh [9].

The mechanical properties decreased from bottom to top and air-dried values were higher (Table 3). Similar opinions were concluded by other investigators [6, 9]. The effect of height on compressive strength was significant and the bottom portion showed the highest value (Table 3) but effect of age was insignificant. The air-dried compressive strength value was higher than the green value. The same conclusion was drawn by Ismail [10]. The node and internode did not show any significant effect on compressive strength. The effects of age and culm height were found significant on the MOR and MOE, and the bottom portion showed the highest value (Table 3), as also concluded by other investigators [9, 10]. The effects of node and internode were insignificant on both physical and mechanical properties.

The correlation coefficient of physical properties with mechanical properties is shown in Table 5. It was observed that the compressive strength had a negative correlation with moisture content, density and shrinkage.

The MOR also had a negative correlation with moisture content and volumetric shrinkage and positive correlation with density. MOE had negative correlation with moisture content but positive correlation with density and shrinkage.

Table 2.
Physical properties of Golla cane

Age group	Height position	Moisture content (%)		Basic density (g/cm^3)		Volumetric shrinkage (%)	
		Node	Internode	Node	Internode	Node	Internode
3 years	Bottom	155	184	0.42	0.45	17.5	19.4
	Middle	189	217	0.29	0.27	25.4	36.2
	Top	194	225	0.27	0.21	27.1	39.5
	Average	179	209	0.33	0.31	23.3	31.7
4 years	Bottom	135	174	0.51	0.55	16.8	19.4
	Middle	179	197	0.32	0.34	26.4	33.2
	Top	184	211	0.28	0.25	32.1	38.1
	Average	166	195	0.37	0.38	25.1	30.2
5 years	Bottom	138	181	0.54	0.56	17.0	20.1
	Middle	175	202	0.37	0.26	24.5	32.2
	Top	185	216	0.31	0.28	33.4	37.3
	Average	166	200	0.41	0.37	24.9	29.9
Average		171	201	0.37	0.35	24.5	30.6

Table 3.
Mechanical properties of Golla cane

Age	Height	Compressive strength (N/mm^2)				MOR (N/mm^2)				MOE (N/mm^2)			
		Node		Internode		Node		Internode		Node		Internode	
		Green	AD	Green	AD	Green	AD	Green	AD	Green	AD	Green	AD
3 years	Bottom	16.3	17.73	13.41	15.55	84.61	91.71	75.51	78.92	9450	12 560	8760	10 320
	Middle	7.21	8.45	6.95	8.23	21.54	25.56	20.24	22.84	8290	11 760	7650	9870
	Top	6.83	7.81	6.53	7.61	16.82	19.61	16.14	17.91	7760	9730	6800	8780
	Average	10.11	11.33	8.96	10.46	40.99	45.63	32.29	39.89	8500	11 350	7730	9650
4 years	Bottom	17.22	18.41	15.25	16.71	87.51	94.66	81.16	84.12	11 740	13 770	10 890	12 850
	Middle	8.13	9.61	8.63	9.86	21.25	28.14	21.33	22.91	10 910	12 400	9340	11 240
	Top	7.56	8.45	7.81	8.32	17.31	21.22	18.31	20.26	7680	11 740	7150	9950
	Average	10.97	12.16	10.56	11.63	42.02	48.06	40.27	42.43	10 100	12 640	9130	11 350
5 years	Bottom	17.72	19.14	16.21	16.51	88.22	96.71	81.45	86.13	13 980	15 240	12 330	12 580
	Middle	8.55	8.93	8.83	9.53	22.74	26.54	21.83	23.55	11 850	13 870	10 590	11 360
	Top	7.42	8.51	8.75	8.41	18.15	22.52	17.58	19.88	10 640	12 930	98 70	10 580
	Average	11.23	12.19	11.26	11.48	43.03	48.59	40.28	43.16	12 150	14 010	10 930	11 500
Average		10.77	11.89	10.26	11.19	42.01	47.42	37.61	41.43	10 250	12 670	9260	10 840

Table 4.
Summary of ANOVA tests

Source of Variations	Physical properties			Mechanical properties					
	MC	Shrinkage	Basic density	MOR		MOE		Compressive strength	
				Green	AD	Green	AD	Green	AD
Age	ns	*	*	*	*	*	*	ns	ns
Height	**	*	**	*	*	**	**	**	*
Internode	ns	ns	ns	ns	ns	ns	ns	ns	ns
Node	ns	ns	ns	ns	ns	ns	ns	ns	ns

*Significant at $P < 0.05$.
**Significant at $P < 0.01$; ns, not significant.

Table 5.
Correlation coefficient of physical properties with mechanical properties

Physical properties	Mechanical properties		
	Compressive strength	MOR	MOE
Moisture content	−0.88*	−0.86*	−0.31 ns
Density	−0.70*	+0.64*	+0.26 ns
Shrinkage	−0.84*	−0.35 ns	+0.18 ns

*Significant at $P < 0.05$; ns, not significant.

CONCLUSIONS

The physical and mechanical properties of Golla cane of north-eastern region, Bangladesh were investigated. The following conclusions were drawn:

1. The effect of age was significant on physical and mechanical properties except for moisture content and compressive strength. Golla bet of the 5 years age group showed highest physical and mechanical properties except for moisture content and shrinkage and the 3 years group showed highest moisture content and shrinkage values.
2. The physical and mechanical properties of Golla bet were affected significantly by increasing height from bottom to top and the bottom portion showed higher value except for moisture content.
3. Effects of node and internode were insignificant on physical and mechanical properties of Golla bet.
4. It is assumed that none of the above statistically significant differences is large enough to adversely affect the processing and utilization of Golla bet from the north-eastern region of Bangladesh.

REFERENCES

1. J. Dransfield, Taxonomy, biology and ecology of rattan, *Unasylva* **52** (2), 11–13 (2001).
2. M. K. Alam, *Rattans of Bangladesh. Bulletin 7, Plant Taxonomy Series*. Bangladesh Forest Research Institute, Chittagong (1990).

3. M. Peki and C. Konabe, Evaluation of moisture content and specific gravity, in: *Proceedings of the National Rattan Workshop, Forest Research Institute*, Lae, Papua New Guinea, C. Konabe and C. B. Sastry (Eds), pp. 23–25 (1991).
4. D. Miah and L. Rahman, Status of rattan-based small scale cottage industries in urban and semi-urban area of Chittagong, Bangladesh, *Journal of Bamboo and Rattan* **1** (3), 251–261 (2002).
5. C. Renuka, Uses of rattan in South Asia, *Unasylva* **52** (2), 1–7 (2001).
6. M. F. Kabir, D. K. Bhattacharjee and M. A. Sattar, Influence of height on physical and mechanical properties of Golla Cane (*Daemonorops jenkinsiana*), *Bangladesh Journal of Forest Science* **22** (1-2), 52–56 (1993).
7. C. Renuka, K. M. Bhat and V. P. K. Nambiar, Morphological, anatomical and physical properties of Calamus species of Kerala Forest, KFRI Research Report, Volume 46 (1987).
8. M. A. Latif, S. A. M. Seman and S. M. Midon, The abrasive resistant of Rattan manu and *Rattan mantang*, in: *Proceedings of the International Rattan Seminar*, Chiangmai, Thailand, pp. 206–212 (1987).
9. S. C. Goh, Testing of Rotan manu-strength and mechanical properties, *Malaysian Forester* **45** (3), 275–277 (1982).
10. H. Ismail, W. M. Majid and B. Putch, Mechanical properties of rattans, in: *Proceedings of the International Rattan Seminar*, Chiangmai, Thailand, pp. 189–197 (1987).
11. H. Yododibroto, Anatomy, strength properties and utilization of some Indonesian rattans, in: *Proceedings of the Rattans Seminar*, Kuala Lumpur, Malaysia, pp. 117–122. The Rattans Information Center, Forest Research Institute, Kepong, Malaysia (1985).
12. *Integrated Forest Management Plan for Sylhet Forest Division*. Bangladesh Forest Department (1998).
13. ASTM, Standard methods of testing clear small specimens of timber, in: *Annual Book ASTM Standards* **4** (10), no. 143-94, ASTM D (Re-approved 1997). ASTM, Philadelphia, PA (1997).