

# Fibre Length and Ray Height Variations in Five Tree Species of Guttiferae of Bangladesh

Mohammed Mohiuddin<sup>1</sup> and M. P. Denne<sup>2</sup>

<sup>1</sup>Bangladesh Forest Research Institute, P. O. Box 273  
Chittagong 4000, Bangladesh

<sup>2</sup>School of Agricultural and Forest Science,  
University of Wales, Bangor,  
Gwynedd LL57 2UW, U. K.

## Abstract

The paper describes the fibre length and ray height of the five tree species, namely *Calophyllum polyanthum* Wall., *Garcinia cowa* Roxb., *G. xanthochymus* Hook., *Kayea floribunda* Wall. and *Mesua ferrea* Linn. of the family Guttiferae. In *G. cowa* and *G. xanthochymus* the fibre length and ray height are higher and longer than those of the other species. These two microscopic features work as good characters in delimitating the species of Guttiferae. There is a progressive trend of increase of fibre length and ray height from near pith to sapwood for all the species.

## সারসংক্ষেপ

এ প্রবন্ধে Guttiferae পরিবারের পাঁচটি কাঠ প্রজাতির (*Calophyllum polyanthum* Wall., *Garcinia cowa* Roxb., *G. xanthochymus* Hook., *Kayea floribunda* Wall. and *Mesua ferrea* Linn.) ফাইবারের দৈর্ঘ্য এবং রে কোষের উচ্চতা বর্ণনা করা হয়েছে। *G. cowa* এবং *G. xanthochymus* প্রজাতির ফাইবার দৈর্ঘ্য এবং রে কোষের উচ্চতা অন্যান্য প্রজাতির চেয়ে বেশি। এ বৈশিষ্ট্যদ্বয় উল্লিখিত পরিবারের প্রজাতি শনাক্তকরণের জন্য গুরুত্বপূর্ণ ভূমিকা রাখে। কাঠের পিথ (Pith) থেকে স্যাপউড (Sapwood)-এর দিকে ফাইবারের দৈর্ঘ্য এবং রে কোষের উচ্চতা ক্রমান্বয়ে বেশি পরিলক্ষিত হয়।

**Key words :** Bangladesh, fibre length, Guttiferae, ray height

## Introduction

Fibre length and ray height are important characteristics of wood. They vary between and within the species (Panshin and de Zeeuw 1980). Fibre length is very variable in hardwoods as also tracheid length in softwood species and is also strongly heritable (Wheeler *et al.* 1965, Smith 1967, Ujvari and SzÖnyi 1973). Though the effect of fibre

length on the final wood properties is usually much less than that of specific gravity it is of special importance for some short fibred hardwood species.

There is very limited information on the horizontal and vertical within-tree variation of fibre length and ray height in the Guttiferae. Metcalfe and Chalk (1957) and Pearson and Brown

(1932) commented on the average fibre length and ray height in some members of that family, but did not mention the position in tree from which specimens were obtained. The present study was conducted to observe the nature of variation of fibre length and ray height from pith to bark of the five species of Guttiferae which are natives to Bangladesh.

## Materials and methods

Wood samples of the five timber species of Guttiferae were obtained from the Xylarium of the Bangladesh Forest Research Institute, Chittagong. The species were *Calophyllum polyanthum* Wall., *Garcinia cowa* Roxb., *Garcinia xanthochymus* Hook., *Kayea floribunda* Wall. and *Mesua ferrea* Linn. Wood samples from pith to bark were collected from the bole of the tree species growing naturally in the forests of Bangladesh. Taxonomic voucher specimens of these species were also preserved in the herbarium of the Institute. The selected wood species used for the present study have been listed in Table 1. Samples of *C. polyanthum* were collected from two different regions to determine

whether there was any variation in anatomical structure with respect to geographical zones.

Fibre length and ray height of each species were measured at three different positions, namely sapwood, heartwood, and near pith across the log. The following formula was used to calculate the sample size required to obtain a mean within a specified percentage of population mean:  $N = t^2 \times s^2 / E^2$  (where, N = sample number required for a specific level of significance, t = value of t from t table (approximating 2 for a large sample), s = standard deviation of the calculating mean, E = percentage of the mean that depends on the level of significance chosen). From a preliminary analysis using this formula, the sample size was set at thirty measurements per position per wood sample, which was estimated to give a mean within 10% of the population mean. Measurements were taken with a light microscope at 40x magnification, using an eyepiece micrometer. Ray height was measured from tangential sections, and fibre length measured from material macerated with glacial acetic acid and 20-vol. hydrogen peroxide.

One-way ANOVA and Tukey's pairwise comparisons were made by "Statistical Package Minitab 12".

Table 1. List of wood specimens of Guttiferae studied.

Species (Scientific name)	Local name	Locality	Sample no.	Xylarium no.
<i>Calophyllum polyanthum</i>	Kamdev	Kaptai, Chittagong Hill Tract	1	FRL 23
<i>Calophyllum polyanthum</i>	Chardua, Kamdev	Daluchera, Sylhet Forest Division	1	FRL 211
<i>Garcinia cowa</i>	Kao	Kaptai, Chittagong Hill Tract	1	FRL-10
<i>Garcinia xanthochymus</i>	Dephal	Muscumba, Chittagong Hill Tract	1	FRL-65
<i>Mesua ferrea</i>	Nageswar	Kaptai, Chittagong Hill Tract	1	FRL-58
<i>Kayea floribunda</i>	Banspatti	Adampur, Sylhet Forest Division	1	FRL-223

Note : FRL = Forest Research Laboratory, Chittagong.

## Results

The minimum, maximum, and mean with standard deviation of fibre length and ray height of the five species are shown in Table 2 and illustrated in Figs. 1 to 4.

## Fibre length

*Fibre length variation from near pith to sapwood* : The variations of fibre length from sapwood to near pith in the five species are illustrated in Fig. 1. It shows that the fibre length

Table 2. Minimum, maximum, mean fibre length and mean ray height with  $\pm$  SD.

Species with specimen number	Position	Minimum fibre length (mm)	Maximum fibre length (mm)	Mean fibre length $\pm$ SD (mm)	Mean ray height $\pm$ SD (mm)
<i>C. polyanthum</i>					
FRL-23	Sapwood	0.94	1.99	1.36 $\pm$ 0.24	0.28 $\pm$ 0.08
FRL-23	Heartwood	0.73	1.85	1.26 $\pm$ 0.22	0.29 $\pm$ 0.07
FRL-23	Near pith	0.64	1.61	1.15 $\pm$ 0.20	0.25 $\pm$ 0.06
FRL-211	Sapwood	0.88	1.58	1.34 $\pm$ 0.17	0.30 $\pm$ 0.09
FRL-211	Heartwood	0.82	1.52	1.30 $\pm$ 0.16	0.30 $\pm$ 0.09
FRL-211	Near pith	0.76	1.52	1.24 $\pm$ 0.19	0.25 $\pm$ 0.08
<i>Garcinia cowa</i>					
FRL-10	Sapwood	1.35	3.53	2.56 $\pm$ 0.54	1.43 $\pm$ 0.59
FRL-10	Heartwood	1.76	3.41	2.42 $\pm$ 0.34	1.32 $\pm$ 0.51
FRL-10	Near pith	1.32	2.41	1.92 $\pm$ 0.27	1.07 $\pm$ 0.29
<i>G. xanthochymus</i>					
FRL-65	Sapwood	1.58	3.47	2.51 $\pm$ 0.44	0.76 $\pm$ 0.24
FRL-65	Heartwood	1.15	3.35	2.48 $\pm$ 0.53	0.73 $\pm$ 0.26
FRL-65	Near pith	1.61	3.29	2.29 $\pm$ 0.39	0.63 $\pm$ 0.22
<i>Kayea floribunda</i>					
FRL-223	Sapwood	0.97	1.67	1.32 $\pm$ 0.14	0.49 $\pm$ 0.18
FRL 223	Heartwood	0.99	1.58	1.35 $\pm$ 0.14	0.50 $\pm$ 0.15
FRL 223	Near pith	0.53	1.55	1.22 $\pm$ 0.20	0.47 $\pm$ 0.19
<i>Mesua ferrea</i>					
FRL 58	Sapwood	0.67	1.47	1.23 $\pm$ 0.17	0.29 $\pm$ 0.09
FRL 58	Heartwood	0.76	1.61	1.25 $\pm$ 0.14	0.30 $\pm$ 0.15
FRL 58	Near pith	0.73	1.47	1.16 $\pm$ 0.17	0.28 $\pm$ 0.12

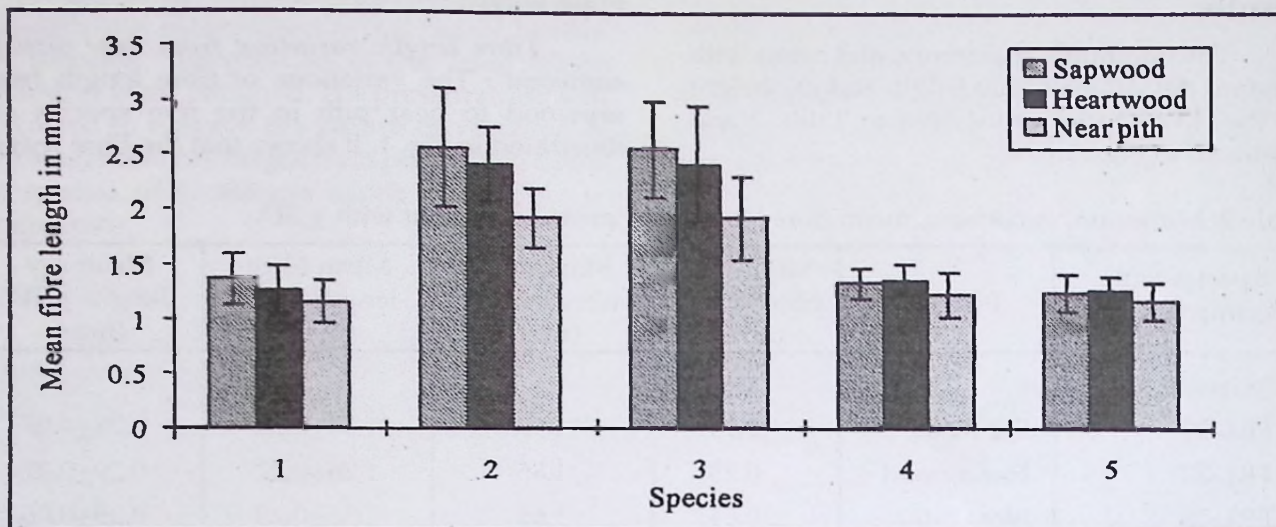


Figure 1. Variation of fibre length in near pith, heartwood and sapwood, in five species of Guttiferae. Vertical lines show standard deviation on each side of the mean 1 *C. polyanthum*, 2 *G. cowa*, 3 *G. xanthochymus*, 4 *K. floribunda*, 5 *M. ferrea*.

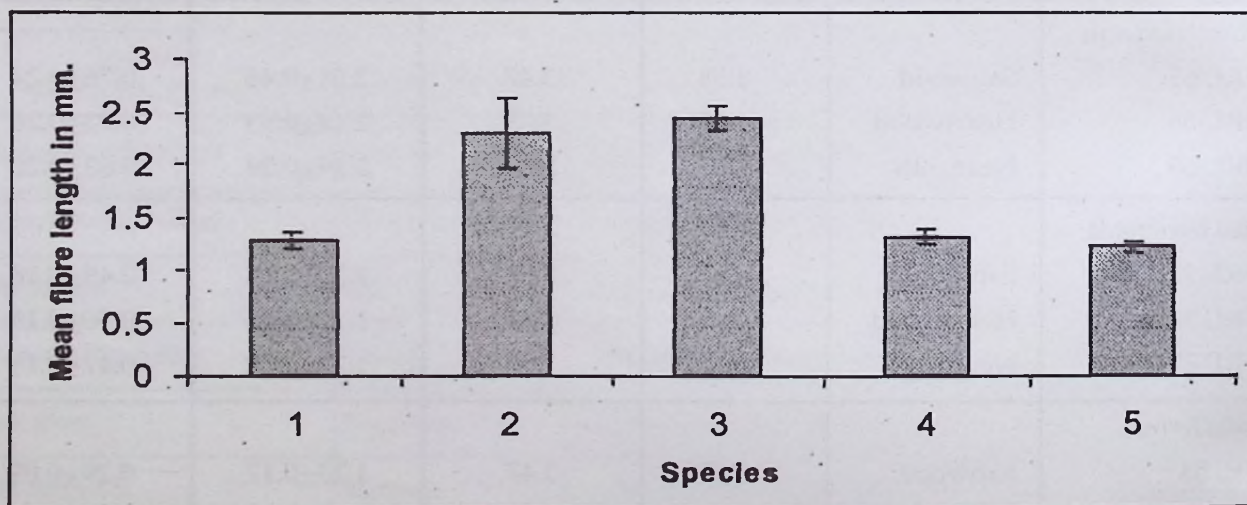


Figure 2. Mean fibre length in five species of Guttiferae. Vertical lines show standard deviation on each side of the mean. 1 *C. polyanthum*, 2 *G. cowa*, 3 *G. xanthochymus*, 4 *K. floribunda*, 5 *M. ferrea*.

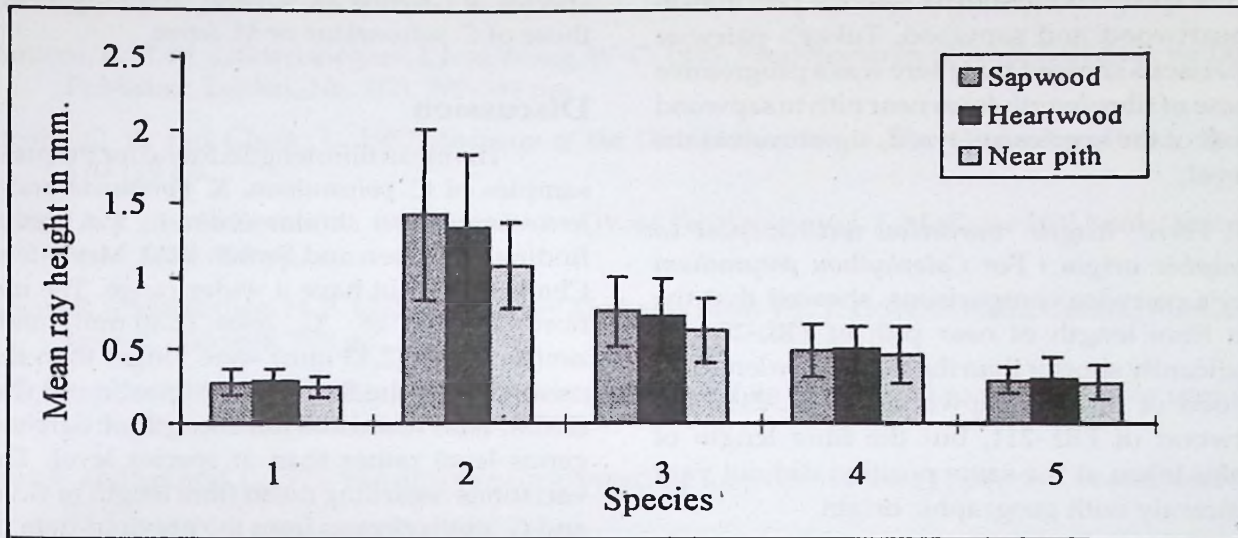


Figure 3. Mean ray height in sapwood, heartwood and near pith in five species of Guttiferae. Vertical lines show standard deviation on each side of the mean. 1 *C. polyanthum*, 2 *G. cowa*, 3 *G. xanthochymus*, 4 *K. floribunda*, 5 *M. ferrea*

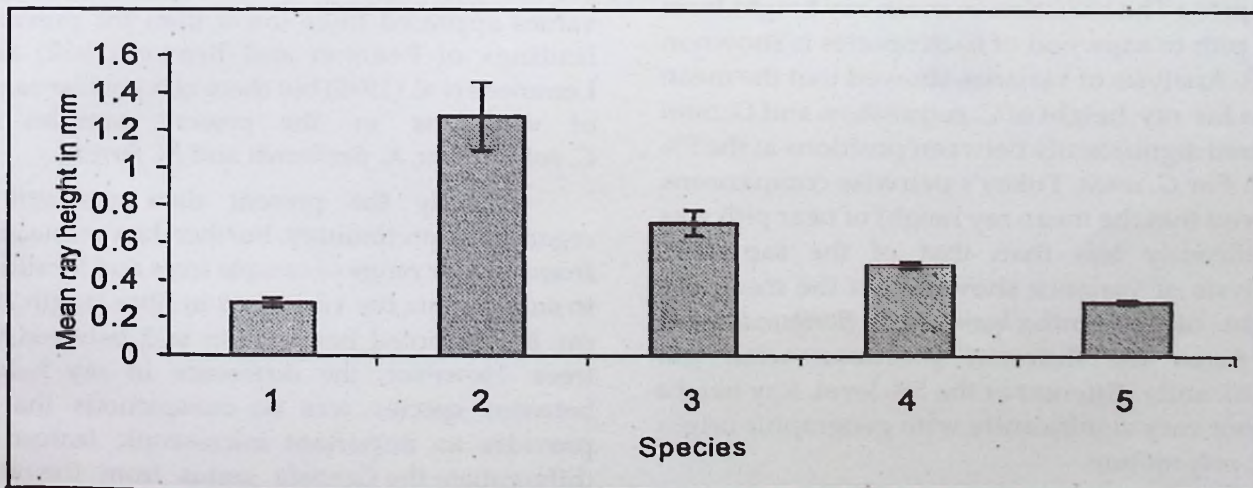


Figure 4. Mean ray height in five species of Guttiferae. Vertical lines show standard deviation on each side of the mean. 1 *C. polyanthum*, 2 *G. cowa*, 3 *G. xanthochymus*, 4 *K. floribunda*, 5 *M. ferrea*.

of all the species were shorter near the pith than in the heartwood and sapwood. Tukey's pairwise comparisons showed that there was a progressive increase of fibre length from near pith to sapwood in most of the species analysed, significant at the 5% level.

*Fibre length variation with respect to geographic origin* : For *Calophyllum polyanthum* Tukey's pairwise comparisons, showed that the mean fibre length of near pith of FRL-23 was significantly shorter than the mean fibre length of sapwood of FRL-23, sapwood of FRL-211, and heartwood of FRL-211, but the fibre length of samples taken at the same position did not vary significantly with geographic origin.

*Variations of mean fibre length between species* : As shown in Fig. 2, mean fibre length varied between the species analysed. The mean fibre lengths of *G. cowa* and *G. xanthochymus* were significantly longer than those of the other three species, which have about the same fibre length.

#### Ray height

*Variation of ray height from sapwood to near pith* : The variation in mean ray height from near pith to sapwood of each species is shown in Fig. 3. Analysis of variance showed that the mean value for ray height of *C. polyanthum* and *G. cowa* differed significantly between positions at the 5% level. For *G. cowa*, Tukey's pairwise comparisons showed that the mean ray height of near pith was significantly less than that of the sapwood. Analysis of variance showed that the mean ray height of *G. xanthochymus*, *K. floribunda* and *M. ferrea* for different positions were not significantly different at the 5% level. Ray height did not vary significantly with geographic origin of *C. polyanthum*.

*Mean ray height of each species* : As shown in Fig. 4, there were very significant differences in ray height between species, the rays of the two

species of *Garcinia* are several times higher than those of *C. polyanthum* or *M. ferrea*.

#### Discussion

The mean fibre lengths found for the present samples of *C. polyanthum*, *K. floribunda* and *M. ferrea* were of a similar order to the previous findings (Pearson and Brown 1932, Metcalfe and Chalk 1957), but have a wider range. The mean fibre length of *G. cowa* (2.30 mm) and *G. xanthochymus* (2.43 mm) were longer than those mentioned in the findings of Metcalfe and Chalk (1957), who noted the fibre length of *Garcinia* at genus level rather than at species level. These variations regarding mean fibre length of *G. cowa* and *G. xanthochymus* from the previous data may be attributed to variation between species, or to geographical locations within Bangladesh, or to the wider range of positions taken within the tree in the present samples. There was a progressive trend of increase of ray height from near pith towards heartwood and sapwood in all the species, though this was significant (at 5% levels) only in *G. cowa*. The tallest rays were found in *G. cowa*, followed by *G. xanthochymus* and *K. floribunda* respectively. These mean ray height values appeared to be lower than the previous findings of Pearson and Brown (1932) and Lemmens *et al.* (1995) but there was a wider range of variations in the present samples for *C. polyanthum*, *K. floribunda* and *M. ferrea*.

Clearly the present data must still be regarded as preliminary. Further data are needed from a wider range of sample trees and localities, to substantiate the variations in fibre length and ray height noted here within and between the trees. However, the difference in ray height between species was so conspicuous that it provides an important microscopic feature to differentiate the *Garcinia* genus from the other three genera. Similarly, differences in fibre length might also provide a useful aid to identify the species of Guttiferae from chips or pulp.

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