

Understanding of Bamboo as Timber Substitute: Chemical and Anatomical Properties of *Bambusa Pallida* Munro. of Kokrajhar District, Assam, India

Sanjib Brahma^a B.K.Brahma^b

Head of the Department, Department of Botany, Science College, Kokrajhar, Assam, India^a

Department of Biotechnology Bodoland University, Assam, India^b

ABSTRACT: Kokrajhar district which is one of the district of Assam state of India has good bamboo resources by having diversity of bamboo species. The district has occurrence of 16 numbers of bamboo species under 5 numbers of genera (Brahma et.al.,2014).

Since the knowing of physical and chemical content is the integral part of bamboo application for different purposes. The present study is to document important content like moisture, alcohol-toluene solubility, water solubility, ash content, lignin, holocellulose, α -celluloses, of *B. pallida* Munro, the bamboo species that occurs in Kokrajhar district.

KEYWORDS: Wood substitute, Kokrajhar district, *Bambusa pallida* Munro. Chemical content of bamboo.

I. INTRODUCTION

The importance of Bamboo to rural community is well accepted as the bamboo is a versatile, multipurpose forest species which provide verities of goods and contributes towards the human economy. Besides fulfilling the daily needs the bamboo has significant position as industrial raw materials that can be compared with plastic and steel (Mustafa et. al.,2011).

In recent years bamboo has been the focus of research and development. Since bamboos are considered as the fastest growing plant on earth that makes them the best possible alternative source of cellulose to replaced timber in future (Liese , 1987).

Bamboo is now a well established sector, its biology and applied aspect have been well studied. With the increases in knowledge and research regarding the gross wood quality and characters many new areas of bamboo application are coming out. Bamboo based industries are now one of the industry which create important impact on country's economy. Many new bamboo based industries are emerging in the country with thousands of products. Beginning with traditional handicraft to engineered conventional bio-composites like Veneer, Lumber etc. bamboo application now reached its second generation application like advanced polymer bio-composite technology. Although both bamboo and wood are comparable by having lingo-cellulosic materials, their processing for different composite manufacture required separate method, technology and equipment. Hence knowing of bamboo wood characters is necessary for a successful wood composite manufacture.(Chaowana ,2013).

Bamboo culm is the upper ground part of a bamboo plant which contains woody materials (Chaowana ,2013). The main chemical constituent of bamboo culms are holocellulose, pentosan , hemicelluloses lignin along with minor constituents like resins, tannins, waxes and inorganic salts. Out of this content the holocellulose constitute the major component by having 60% to 70%, pentosans by 20% to 25%, hemicelluloses and lignin by having 20% to 30% (Tomalang et.al.,1980). In compared to wood the chemical property of bamboo does not show basic differences among

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

species. The growing condition and aging have also not significant effect on tissue composition of bamboo (Razak et.al.,2009; Liese et.al.,1992; Liese, 1985).

The basic chemical composition for better utility of bamboo consists of about 50% to 70% holocellulose and 20% to 25% lignin. There are differences in these constituents among the species but their influences on technological properties are uncertain (Liese et.al.,1992).

Bambusa pallida Munro is a thickly growing, graceful evergreen or semi deciduous species .In North East India its distribution is in Arunachal Pradesh, Assam, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Northern part of West Bengal (Barooah et.al,2003). Presently this bamboo is used for making of rural house, mat and other basketry (Gamble, 1896).In Tripura many artistic crafts like different toys, wall plates, wall hangers etc. are made from this bamboo (Chakraborty ,1988). In Assam this bamboo is used for making of rural houses, minor crafts and basketry (Barooah et.al,2003).

This study of chemical and anatomical properties of *B. pallida* Munro facilitates to gather comprehensive knowledge on different chemicals and its solubility. In this study fibre and vascular bundle along with important culm characters like culm wall thickness, culm diameter, culm length were studied.

II. METHOD AND EXPERIMENT

For these studies five (5) numbers of individual bamboo plants were harvested from different locations of the study area. During selection of the individual plants care was taken to collect the plants of same culm height, same culm diameter and of same age which is above one year.Immediately after the harvesting the plant the culm height, culm diameter, internodes length, culm wall thickness, leaves, culm sheath were observed and measured.

To determine the different anatomical and chemical content the sample is prepared from the harvested bamboo plant. The sample was prepared from breast height diameter (BHD) portion which comes about 131.92 cm above the ground. The sample was in the form of powder and strips as and when required.

The method for studying different contents i.e. the standards of American Society for Testing and Materials (ASTM) were followed.

Determination of moisture content:

To determine the moisture content a 10mmX10mm thickness sample block was prepared. The measurement of fresh weight was done immediately after the collection of sample. To obtain the dried weight the sample block was oven dried at $105\pm 2^{\circ}\text{C}$ for 48 hours. The measurement of dried weight was repeated till it gets constant weight. To obtain constant dry weight desiccator was used.

Solubility in Alcohol-toluene:

Around 2gm oven dried bamboo sample was done soxhlet extraction by using 2:1 solution of ethyl alcohol (92%) and Toluene respectively. The extraction frequency was done Six (6) siphoning/ hours for eight (8) hours. The extract was oven dried at $103\pm 2^{\circ}\text{C}$ and measured with gravimetric.

Water solubility percentage:

Around 2gm of oven dried bamboo sample was mixed with 100ml of distilled water into an Erlenmeyer flask; a condenser was attached to the flask to shack the evaporation. The whole setup was then gently boiled into a water bath for 3 hours. The content was filtered and the filtrate was oven dried at $103\pm 20^{\circ}\text{C}$ and measured.

Ash content percentage:

Around 2gm of oven dried bamboo sample was igniting in the muffle furnace until all the carbon was removed. The heating was slowly and increases up to the final heating 580°C to 600°C .

Determination of Klason Lignin content %:

Around 2gm of oven dried bamboo sample was taken in to a beaker of 150ml. and mixed with 15ml of H_2SO_4 (72%) slowly. The reaction was allowed to continue for 2 hours by placing the whole set into a water both maintained

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

at 20°C. After the 2 hours reaction 560ml of distilled water was added to dilute the H₂SO₄. The whole set up was placed in a boiling water bath, during the process a glass condenser was added to the flask. The content of the flask was collected and oven dried at 103±2°C.

Determination of Holocellulose percentage:

Around 2gms of dried bamboo sample was taken into an Erlenmeyer flask of volume 250ml. A 150 ml of distilled water, 0.2 ml of glacial acetic acid and 1 gm of NaClO₂ was added to the sample. After addition it was mixed well by rotating the flask then the whole set up was placed into a 70°C water bath. As the temperature rises the reaction exerts. The reaction was allowed to continue for about 5 hours. After the reaction the flask was cooled at ice water to lower the temperature to 10°C. The content of the flask was then oven dried at 103±2°C and measured.

Determination of α-cellulose content percentage:

To determined α-cellulose content around 2gms of oven dried holocellulose sample was mixed with 50ml of NaOH (17.5%) and allowed to reaction into a 250ml. Erlenmeyer flask. After few minutes of reaction, 50ml of distilled water was added and mixed well by rotating the flask. For the whole process the water bath was maintained at 20°C. The filtrate was washed with 50ml NaOH(8.3%) and then 40ml. Acetic acid (10%) and finally washed with hot water to make the content acid free. The content was oven dried at 103±2°C and measured.

Study of Anatomical characters

Study of vascular bundle

To study the vascular bundle the bamboo sample was cut into a 45micron thickness transverse section with a microtome machine. With the section that obtain a temporary permanent preparation of slide was done by adding aqueous safranin stain. Oven drying of prepared section was done at 40°C for 8 hours.

The determination of the vascular bundle concentration was done by using of the prepared slide. Microscopic observation of the slide was done in a light compound microscope at 5X magnification. The focused area was divided into three outer, middle and inner horizontal layers. Vascular bundle was counted separately from each horizontal layer and the area was measured and converted to cm.

To measure the vascular bundle, same slide was using and focused under light microscope at 10X magnification. Five (5) numbers of vascular bundle was measured from randomly selected vascular bundle from each cross section (outer, middle, inner) the focused area with the help of a camera fitted microscope and ScopeImage 9.0(HIC) software. Care was taken to not to measure the shorter and longer vascular bundle and also taken care to discard the repeated value of measurement.

Measurement of fibre length

The maceration of bamboo fibre was done by using maceration solution of glacial acetic acid, hydrogen peroxide (30%) and distilled water in ratio 5:1:4 respectively. To perform the test the bamboo sample was cut into 0.25x0.25x5cm. size and then the pieces were macerated with the maceration solution. The maceration reaction was allowed to continue for 48 hours at 60°C. The randomly selected fibre from the focused area was measured by using camera fitted microscope and ScopeImage 9.0(HIC) software. Care was taken to not to measure the shorter and longer vascular bundle and also taken care to discard the repeated value of measurement.

III. RESULTS AND DISCUSSION

The basic morphological structure of *B. pallida* Munro. has studied. The result shows that, the size of this bamboo is comparatively small by having culm diameter 3-6.5cm. and culm height 800-2000cm. The morphological characters of culm sheath like length, breadth, texture, shape and colour varies species to species and it is considered as important characters for bamboo identification (Chatterji et al. 1963). During study the size of leaves and culm sheath of *B. pallida* Munro were measured 8-25cm (length), 0.9-2.5cm (width) and 16-30cm (length), 20-25cm (width) respectively.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017



Photograph 1. *B.pallida* Munro. [A]- culm structure.

Sample no.	Number of individual sample studied	Average total numbers of internodes (nos.)	Average length of internodes (cm)	Average culm height (cm)	Average culm diameter (cm)	Average culm wall thickness (cm)	Average length of leaves (cm)	Average breadth of leaves (cm)	Average length of culm sheath (cm)	Average breadth of culm sheath (cm)
3	5	40	30-45	800-2000	3-6.5	0.5-1.5	8-25	0.9-2.5	16-30	20-25

Table 9: *B.pallida* Munro. Gross morphological structure.

In bamboo the hot water solubility includes tannin, gums, sugars, starches, colouring matter and the alcohol-toluene solubility primarily includes waxes, fats, resins, some gums, and some water solubility substances. In this study the average hot water solubility and alcohol-toluene solubility percentage was recorded $7.879 \pm 0.51\%$ and $6.164 \pm 0.21\%$ respectively. Result shows comparatively low water solubility content of *B. pallida* Munro. which is one of the important characteristics for better utility of a bamboo, as higher is the water solubility the lower will be the pulp yield. The holocellulose content of this bamboo is up to standard of better utility of bamboo while the lignin content is lower by having values $61.076 \pm 0.70\%$ and $18.358 \pm 0.97\%$ respectively. Average of α -cellulose percentage is $38.937 \pm 0.95\%$

Sample no.	Average of moisture content Percentage (in gm/100gm)	Average of alcohol-toluene soluble percentage (in gm/100gm)	Average of water soluble percentage (in gm/100gm)	Average of ash content percentage (in gm/100gm)	Average of Klason Lignin percentage (in gm/100gm)	Average of Holocellulose percentage (in gm/100gm)	Average of α -cellulose percentage (in gm/100gm)
1	89.449 ± 4.42	6.164 ± 0.21	7.879 ± 0.51	1.102 ± 0.01	18.358 ± 0.97	61.076 ± 0.70	38.937 ± 0.95

Table10: Average percentage value of important contents and solubility of *B.pallida* Munro. moisture content; alcohol-toluene solubility; water solubility, ash content; klason lignin; holocellulose; α -cellulose.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

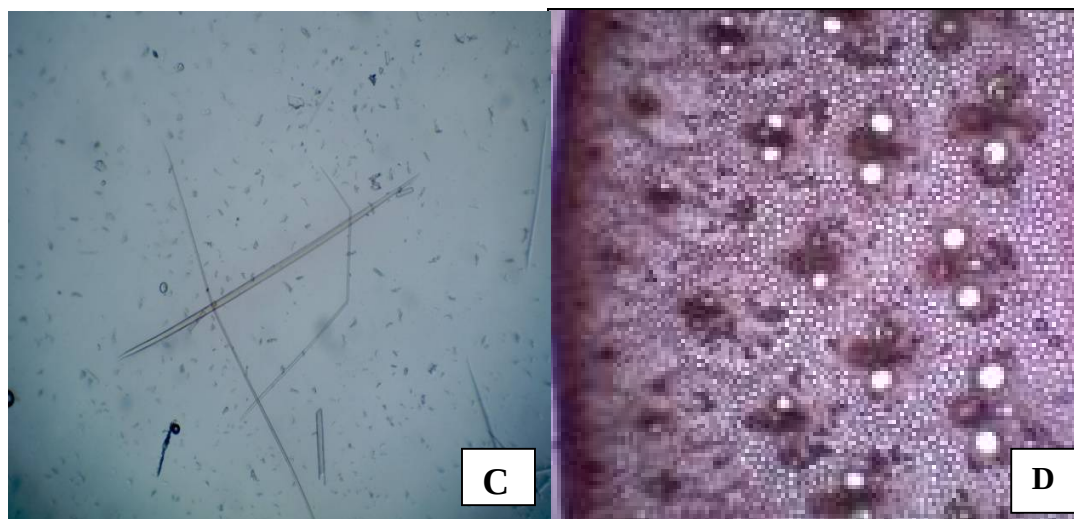
Vol. 6, Issue 7, July 2017

The three layers of the cross section of the slide (inner, middle, outer) show length of the vascular bundle ranges, 767 μ m to 800 μ m for inner layer, 775 μ m to 803 μ m for middle layer and 818 μ m to 860 μ m for outer layer. Altogether 75 slides were studied for the test from 5 numbers of individual bamboo samples by preparing 15 numbers of slides for each sample.

The result of the vascular bundle length shows that the maximum length was in inner layer of the cross section and decreasing towards middle and outer layer however concentration of vascular bundle is higher in outer layer and decreasing towards middle and inner layer.

The gross average fibre length was studied. The result shows the average fibre length of *B. pallida* Munro. is 2.169 $\pm$ 0.12mm.

Sl.no.	Average Fibre length (mm)	Average concentration of vascular bundle (bundles/cm ²)	Average length of vascular bundle (μ m)
1	2.169 $\pm$ 0.12	238 $\pm$ 05.81	787.837 $\pm$ 0.70



Photograph 2. *B.pallida* Munro. C- Fibre structure; D- Vascular bundles.

IV. CONCLUSIONS

In present study the chemical and anatomical properties of *B. pallida* Munro. a less utilise bamboo species of Kokrajhar district have done Due to its comparatively small size and lesser known, this bamboo is presently used in many traditional applications only. The result of the present study of various content of *B. pallida* Munro. can be compared with the content of the several regular user bamboo including *B. tulda*, The fibre length of this bamboo is even longer than softwood.

Although this bamboo species is small in size and lesser known, the studies show that its important content is not much lesser than other regularly used bamboo species. By considering the result from the study it is concluded that *B. pallida* Munro. may be recommend for different industrial uses along with traditional basketry uses.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

REFERENCES

- [1]. B .K. Brahma , A. Basumatary, J. Basumatary, D. Narzary, N. Mwshary, S. Jamatia, P. Basumatary, A. K. Goyal, 2014. Inventorying bamboo diversity of Kokrajhar district,BTAD,Assam,India with emphasis on its uses by Bodos and allied tribes, Int. J. Fund. Appl. Sci. 3(3): 30-34.
- [2]. C. Barooah , S.K. Borthakur. 2003. *Diversity and distribution of bamboos in Assam*. M/s Bishen Sing Mahendra Pal Singh,Dehra Dun.
- [3]. D.Chakraborty ,1988. Utilisation of bamboos as raw material in the handicraft industries in Tripura. Indian Forester 114.
- [4]. F.N. Tomalang , A.R. Lopez, J.A.Semara, R.F. Casin,Z.B.Espiloy., 1980. *Properties and utilization of Philippine erect bamboo..* In international seminar on bamboo research in Asia held in Singapore, May 28-30, 1980, proceeding 266-275.
- [5]. J.S.Gamble, 1896. The Bambuseae of British India. Annals Royal Botanical Garden,Calcutta 7(1): 1-133.
- [6]. M. T. Mustafa, W.Razak, S.Mahmud, Othman Sulaiman, Nurul Ain' Mohd Kamal, Izyan Khalid.2011. *Anatomical and Microstructures Features of Tropical Bamboo, Gigantochloa brang, G. levis, G. scotechinii and G. wrayi*, Int. J. Forest, Soil and Erosion, 1(1) : 25-35.
- [7]. P.Chaowana ,2013. *Bamboo: An alternative raw material for wood and wood-based composites*. J. of Materials Science Research 2(2): 90-102.
- [8]. R.N.Chatterji , M.B. Raizada,,1963. *Culm sheaths as an aid to identification of bamboo*. Indian Forester 89:744-756.
- [9]. S.Biswas , 1988.*udies on bamboo distribution in north eastern region of India*. Indian Forester 114: 514-531
- [10]. W.Razak , A. Mohammed, M.T.Mustafa, A. Hassan,2009. Physical characteristics and anatomical properties of cultivated bamboo (*Bambus vulgaris schrad*) culms, Journal of Biological Sciences 9 (7):753-759.
- [11]. W. Liese, 1985. Anatomy and properties of bamboo. Proceedings of the international bamboo workshop, Hangzhou,China. October 6-14, 1985.
- [12]. W. Liese , S.Zhu, W. Li, X. Zhang, Z.Wang (Eds.).1992. Bamboo and its use. Proceeding of the international symposium on industrial use of bamboo Beijing, China December 7-17, 1992.
- [13]. [8]. W.Liese , 1987.*Anatomy and properties of bamboo*. Recent research on Bamboo, Ed.:Chino Acad. Of forestry, Peking, and IDRC, Canada. 1987, 196-208.