

CHAPTER - 6

CONCLUSION

The present studies have included all the major physical, chemical and anatomical parameters for analysis. The results obtained from most of the bamboo species among studied bamboos have shown similarities with the results described by several workers. The gross physical, chemical and anatomical properties of *B. garuchokua* and *B. polymorpha* are comparable with regular used bamboo including *B. tulda* and *B. vulgaris*.

The result, of the present study shows the correlation between ash and moisture content. The result shows positive correlation, as higher the moisture content, higher the rate of ash content. This correlation means the content of mineral and inorganic materials which are content of water and the ash is the indicator of the presence of inorganic materials in the lignocellulose substance. The moisture content of bamboo is one of the important factors to determine its utility. The chemical, physical and anatomical characters of bamboo are altering along with the moisture content. Several workers showed the difference in gross chemical, physical and anatomical characters of bamboo in different locations *i.e.* bottom, middle and top of same bamboo culm where moisture content is different. The influence of moisture content on durability of bamboo has studied by several workers. The results of the moisture content of present studied species *i.e.* *Bambusa garuchokua* ($59.34 \pm 1.69\%$), *B. assamica* ($60.39 \pm 1.34\%$), *B. pallida* ($60.19 \pm 1.92\%$), *Melocanna baccifera* ($60.25 \pm 0.67\%$), *B. polymorpha* ($59.57 \pm 1.41\%$), *B. bambos* ($56.29 \pm 3.02\%$) are within the range of several regular used bamboos including *B. blumeana* (57 to 97%) and *Dendrocalamus strictus* (55 to 95%). Hence, the durability of the present selected bamboo may be compared with many regular used bamboos.

The results of the hot water solubility content of the studied bamboo species also satisfy the statement that the higher water solubility content, the lower the pulp yield. The studied bamboo species contain comparatively low hot water solubility content with ranging from 5.54 ± 0.03 to $7.01 \pm 0.12\%$ as shown in **Table 5.3** which is comparable

with regular used bamboo species including *B. tulda* (6.8%) and *B. balcooa* (7.0%). The chemical content of 3 years old *D. brandissii* by having, alcohol-toluene extractives ($2.06\pm 0.15\%$), holocellulose ($72.52\pm 0.42\%$), acid insoluble lignin ($28.72\pm 0.93\%$) and acid soluble lignin ($2.95\pm 0.39\%$), ash content ($2.78\pm 0.39\%$) makes this bamboo suitable for pulp making. The bamboo pulp contain good amount of natural lignin are use in the production of newsprint paper. The result of the chemical content of the present study of 6 numbers of bamboo species are close to the content of *D. brandissii*, hence all the studied bamboo species may be suitable for newsprint paper. The recommendation on pulp and paper making bamboo from chemical point of view tells about the content of 34% and above α -cellulose content is a promising quality, as α -cellulose is non degraded high molecular weight cellulose. The result of α -cellulose content of the present study ranges from 37.51 ± 0.35 to $46.04\pm 2.83\%$ as shown in **Table 5.7** which satisfy this recommendation.

The fiber lengths of several commercial bamboos have been studied by some authors. The average fiber length of *B. tulda*, *B. vulgaris*, *Dendrocalamus giganteus*, *Gaudua angustifolia*, *P. edulis* and *Fargesia yunnanensis* were 3 mm, 2.3 mm, 3.2 mm, 1.6 mm, 1.5 mm and 1.8 mm respectively. This value is very close and comparable with the fiber length of present studied bamboo species. The fiber length and diameter (L/D) $\mu\text{m}/\mu\text{m}$ ratio of studied bamboo species are in good range, with *B. garuchokua* (149.75), *B. assamica* (149.92), *B. pallida* (147.71), *M. baccifera* (148.02), *B. polymorpha* (145.92), and *B. bambos* (154.12). These results satisfy the statement that the L/D ratio of 100 $\mu\text{m}/\mu\text{m}$ and above is better pulp fiber for paper making. Since all the studied bamboo species are having more than 100 $\mu\text{m}/\mu\text{m}$, L/D ratio, they may be suitable for papermaking.

The bamboo fiber length from 2 to 4 mm is very similar to the fiber length of certain softwood. This range of fiber length is very close to the fiber length of present studied species that ranges from 2.2912 ± 0.16 mm (*B. garuchokua*) to 2.3850 ± 0.07 mm (*B. assamica*) as shown in **Table 5.18**. Therefore the bamboos from the studied species may be used as wood substitute material in pulp and paper industries. The fiber length character and applicability of bamboo was studied by several workers. There is

comparatively shorter fiber length in some bamboos including *Phyllostachys edulis* (1.5 mm), *Phyllostachys pubescens* (1300 μm) in compared to other longer fiber containing bamboo like *Dendrocalamus giganteus* (3200 μm), *Oxytenanthera nigrociliata* (3600 μm), *D. membranaceus* (4300 μm). Although this mentioned fiber length is shorter than hardwood but longer than popular softwood *Eucalyptus spp.* (960 to 10400 μm) which is mostly used as short fiber pulp in paper industry. The result of the fiber length of present study is close and comparable with the above mentioned results hence the studied bamboo species may be used as a pulp for paper industries.

The application of bamboo as a raw material in wood based or bamboo based industrial product of 20th century are getting importance. Products like particleboard (PB), medium density fiberboard (MDF), hard fiberboard (HB), oriented strand board (OSB), oriented strand lumber (OSL), parallel strand lumber (PSL), wood plastic composites (WPC) are the product where certain qualities of bamboo are exploited. *B. blumeana* and cement binding OSB could be a bench mark for such product. The mechanical properties including MOR, MOE and Compression strength of *B. blumeana* which is very close and comparable with the result of present studied species including *B. garuchokua* and *B. pallida*. So, the bamboo species from the present study may be suitable for OSB manufacturing.

The correlation of MOE, MOR and Shrinkage of bamboo have a unique pattern with outer layer have higher tangential shrinkage, lower longitudinal shrinkage and higher modulus of elasticity (MOE) and higher modulus of rupture (MOR) in compared with inner layer. The data shown in **Table 5.13** of the present studied bamboo species followed the same pattern which is the important character of regular used bamboo. In bamboo fiber length have a negative correlation with shear strength, which established the arguement of shear failure due to longer fiber length.

The study on some Indian bamboos for category wise application, based on physico-chemical and mechanical properties have done by several workers. Their recommendation on *B. tulda*, *B. nutans* and *G. macrostachya* for various structural uses based on higher strength .The results of important content and qualities of the present

studied species can compare with many species mention by them, hence the present selected species may be used for structural uses. The recommendation given by many workers on *D. strictus* by stating that this bamboo has good mechanical properties and sustainable material for green building with high compressive and tensile strength. The *D. strictus* has tensile strength of 95.781 MPa and compression strength with 77.79 MPa across the length. The result of the present study shows the compression strength of *B. garuchokua* with 73.85 ± 3.24 MPa, *B. polymorpha* with 71.89 ± 3.05 MPa, *B. bambos* with 70.43 ± 2.01 MPa and *B. pallida* with 69.32 ± 2.88 MPa, which is very close and comparable to that of *D. strictus*. Hence, these bamboos may be used for construction and also as reinforcing material.

Besides the present analysis and statement, the result of studied bamboo species viz. *B. garuchokua*, *B. assamica*, *B. pallida*, *M. baccifera*, *B. polymorpha* and *B. bambos*, from Kokrajhar district of Assam, India may be useful for different user groups including structural experts for further analysis.