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Physico-chemical analysis of *Ceiba pentandra* (Kapok)

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ABSTRACT : The *Ceiba pentandra* plant wood was collected from different regions for proximate composition using TAPPI procedure, Canadian standard method. The chemical analysis reveals that the Kapok wood contains low ash content than *Anthocephalus indicus* and high value than *Pinus patula*. Solubility, lignin content and other non-polysaccharide contents have been recorded in the table. The study of wood of *Ceiba pentandra* was analyzed for the determination of its constituents and its suitability for pulp and paper manufacture.

Keywords : Pulp, Stereoregular, Luman width, Slender ratio and Runkel ratio

INTRODUCTION

The most important raw material of the pulp and paper industry is pulpwood. The world wood fibre [3] is the original source of over 98% of the fibrous component of paper in the world. The continued growth and economic prosperity of the industry depends on abundant sources of wood of suitable quality and acceptable cost. Pulp is a product that is derived from wood and other cellulosic plant materials by mechanical or chemical treatment. Kapok [1,2] is soft wooded trace nature to tropical Africa and common along West cost of India (Mumbai). *Ceiba pentandra* wood is variable in colors from white to light brown. The wood is very light with specific gravity 0.25g/cc. The principal components of wood [4] are cellulose 40-55%, lignin 15-35%, hemicelluloses 20-35%, in addition to this the wood contains some minor components which vary with species. Cellulose is the most abundant polysaccharide. It is a high molecular weight stereoregular [5] linear polymer of repeating α-D-glucopyranose units. The hemicelluloses [7,11] of woods are generally considered to be consist of several types of amorphous polymeric carbohydrates that occur through the woody structure of plants. Lignin is an amorphous substance that is partly aromatic in nature, it contains methoxyl groups and aliphatic and phenolic hydroxyl groups. Lignin gives the structural rigidity, stiffening and holding the fibres together.

EXPERIMENTAL

The *Ceiba pentandra* logs were collected from Himachal Pradesh and West coast of India (Mumbai). The bark was removed manually and dried, debarked logs were prepared into chips of suitable size that remain between 2-5 mm. The chips are grind and the dust so obtained was passed through 40 mesh and retained on 60 mesh was collected. This wood dust was chemically analysed for the determination of Ash Content, Cold and Hot Water Solubility, Ether Solubility, Soda Solubility [13], Lignin Content [14], Pentosan Content, Holocellulose, Acetyl Value, Methoxyl Value and Uronic Value etc. And was also analysed for proximate composition using TAPPI procedure [15], Canadian standard method. The physical characteristics like Density, Fibre Length, Luman Width and cell wall thickness of wood dusts and its fibres are measured by TAPPI standard procedures [18].

RESULTS AND DISCUSSION

The results of analyses are recorded in Table-1 and compared with other data of fibrous pulp raw material graphically in Fig.1. Chemical analysis gives an idea about the category to which the wood belongs. Wood of *Ceiba pentandra* is fast growing, easy in debarking and chipping, gives high yield and quality pulp [20]. The comparative study of the chemical analysis of *Ceiba pentandra* dust reveals that its wood contains slightly lower Ash content than *Anthocephalus indicus* but higher than *Pinus patula*. Ash content of wood gives the idea about the non-volatile and inorganic portion of raw material. It has high Cold and Hot water solubility than *Pinus patula* and *Anthocephalus indicus*. Water solubility of wood represents the low molecular weight compounds and polysaccharides. Its Alcohol-Benzene solubility is also greater than *Pinus patula* and *Anthocephalus indicus*. The one percent sodium hydroxide solubility of *Ceiba pentandra* is higher than *Pinus patula* and *Anthocephalus indicus*. Sodium hydroxide solubility shows the extent of fungal decay in wood. As fungal decay causes increase in sodium hydroxide solubility. The Lignin content is almost the same in *Ceiba pentandra* and *Pinus patula* but higher than *Anthocephalus indicus*. Lignin content in wood is considered to be undesirable and represents the carbohydrate fractions. The Pentosan contents are higher than *Pinus patula* and *Anthocephalus indicus*. Higher the Pentosan content, denser is the pulp which is favourable for good pulping. The Holocellulose value of *Ceiba pentandra* is lower than *Pinus patula* and *Anthocephalus indicus*. The Holocellulose [9] content is a quantitative indication of fibrous raw material influencing consideration of its suitability for pulp.

Table 1: Comparison of Chemical Analysis of *Ceiba pentandra*, *Pinus patula* and *Anthocephalus indicus*.

Wood Dust	*Ceiba pentandra*	*Pinus patula*	*Anthocephalus indicus*
Ash Content	1.05	0.18	1.27
Cold Water Solubility	4.08	3.02	3.42
Hot Water Solubility	7.00	5.90	5.31
Alcohol Benzene Solubility	3.82	3.10	2.32
1% NaOH Solubility	24.25	14.60	19.77
Lignin Content	29.46	28.70	23.09
Pentosan Content	20.52	11.90	15.58
Holocellulose	60.90	71.68	68.20
α - Cellulose	42.80	40.00	65.00
β - Cellulose	12.52	11.80	14.85
γ - Cellulose	16.68	15.56	16.00
Acetyl Value	1.56	2.02	3.22
Methoxyl Value	2.32	2.25	5.40
Uronic Anhydride	1.98	1.85	3.66

The α-cellulose of *Ceiba pentandra* is slightly higher than *Pinus patula* but much lower than *Anthocephalus indicus*. The value of β-cellulose remains almost the same and the value of α-cellulose of *Ceiba pentandra* wood dust is slightly greater than *Pinus patula* and *Anthocephalus indicus*. The Acetyl value, Methyl content and Uronic anhydride value is almost the same in *Ceiba pentandra* and *Pinus patula* but lower than *Anthocephalus indicus*.

Physico analysis data indicate the pulping quality. Basic density of *Ceiba pentandra* wood is 0.42 g/cm^3. Its value is slightly higher than *Pinus patula* but lower as compared to *Anthocephalus indicus*. The value of Cell wall thickness is almost the same as that of Average fiber length [4], Dimensions and Luman width of *Ceiba pentandra* were found 1.85 mm, 0.025 mm and 0.0154 mm respectively. These values are higher as compared to *Anthocephalus indicus* wood but are lower than *Pinus patula* wood. The results of data of the physical observation and calculation of fibre dimension is recorded in Table-2 and Table-3 and compared to that of the others graphically in Fig.2 to 6. On calculation of physico analysis data [12] the Slender ratio is 74.0 of *Ceiba pentandra*. This ratio is higher than *Pinus patula*. But the value of Runkel ratio of *Ceiba pentandra* is lower as compared to *Pinus patula* and *Anthocephalus indicus* wood. The Shape factor values of wood of *Ceiba pentandra* is 0.4498. These values are slightly different than those of *Pinus patula* and *Anthocephalus indicus* wood.

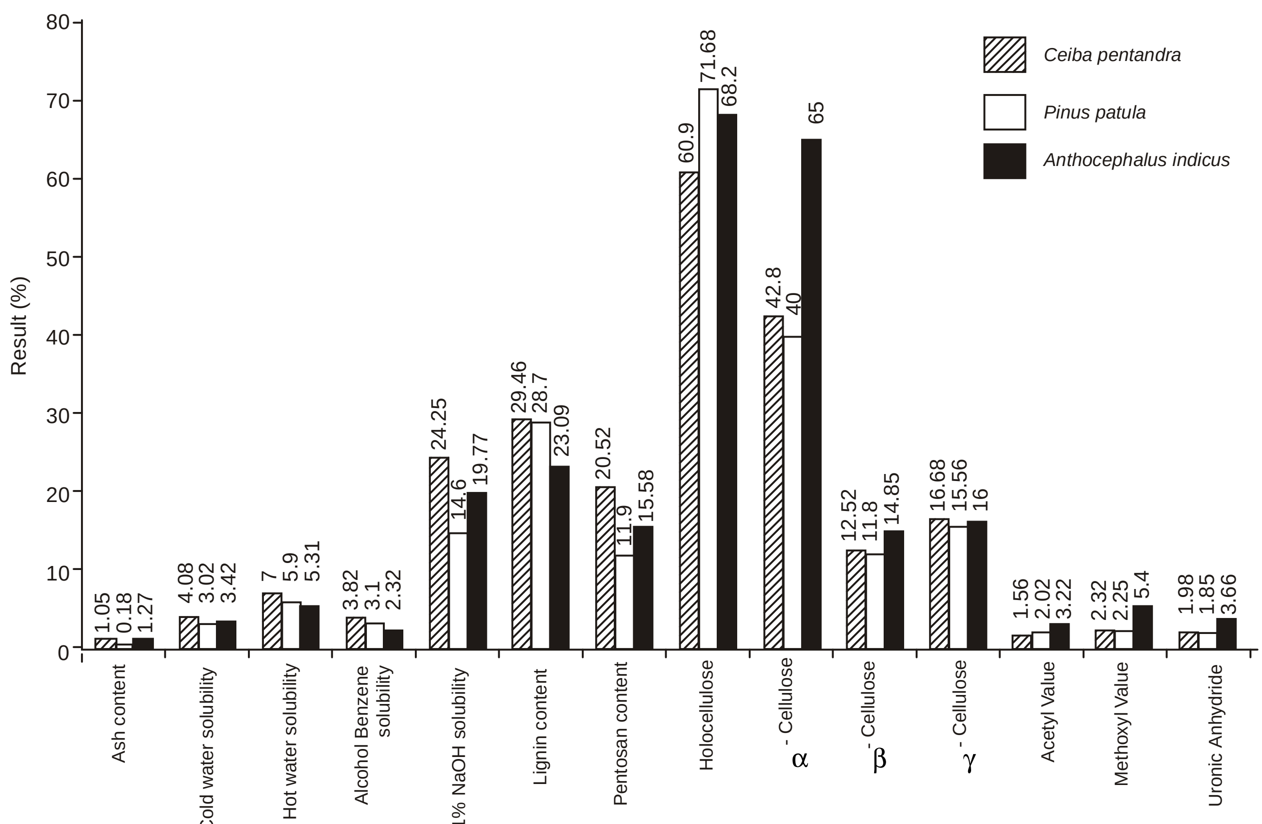

Fig.1. Comparison of chemical analysis of *Ceiba pentandra, Pinus Patual* and *Anthocephalus indicus.*

Table 2 : Comparison of Physico Analysis data of *Ceiba pentandra, Pinus patula* and *Anthocephalus indicus*.

Wood Dust	*Ceiba pentandra*	*Pinus patula*	*Anthocephalus indicus*
Cell Wall Thickness 'W' (mm)	0.0035	0.0037	0.0040
Average Fibre Dimension 'D' (mm)	0.025	0.028	0.022
Luman Width 'l' (mm)	0.0154	0.0158	0.0150
Basic Density of Wood (g/cm^{3})	0.42	0.38	0.51
Average Fibre Length 'L'(mm)	1.85	2.40	1.21

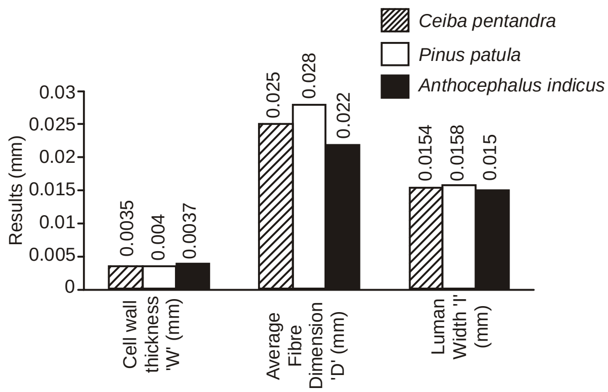

Fig.2. Comparison of cell wall thickness, average fibre dimensiona nd luman width of *Ceiba pentandra*, *Pinus patula* and *Anthocephalus indicus* wood dust.

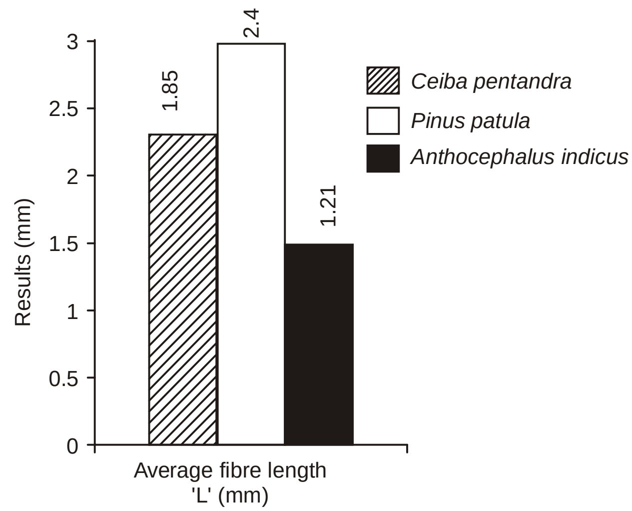

Fig.4. Comparison of average fibre length of *Ceiba pentandra, Pinus patula* and *Anthocephalus indicus.*

Table 3 : Comparison of Physico Analysis data. of *Ceiba pentandra, Pinus patula* and *Anthocephalus indicus*.

Wood Dust	*Ceiba pentandra*	*Pinus patula*	*Anthocephalus indicus*
Runkel Ratio (2W/l)	0.4545	0.4683	0.5333
Shape Factor (D2-l2 /D2+l2)	0.4498	0.5169	0.3653
Slender Ratio (L/D)	74.00	85.71	55.00

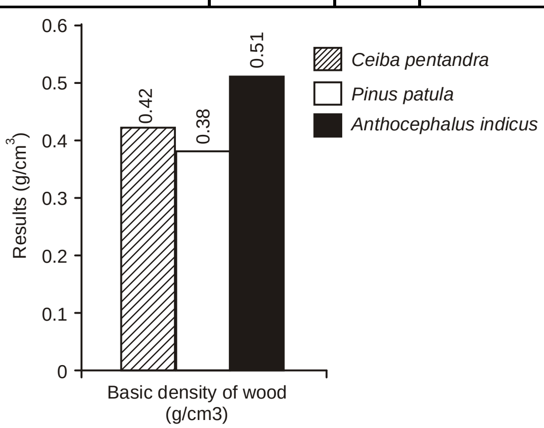

Fig.3. Comparison of basic density of *Ceiba pentandra*, *Pinus patula* and *Anthocephalus indicus*.

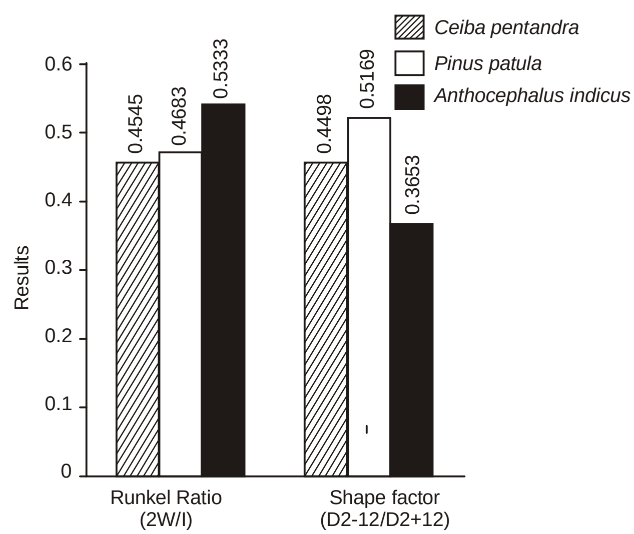

Fig.5. Comparison of runkal ratio and shape factor by physico analysis data of fibre of *Ceiba pentandra, Pinus patula* and *Anthocephalus indicus.*

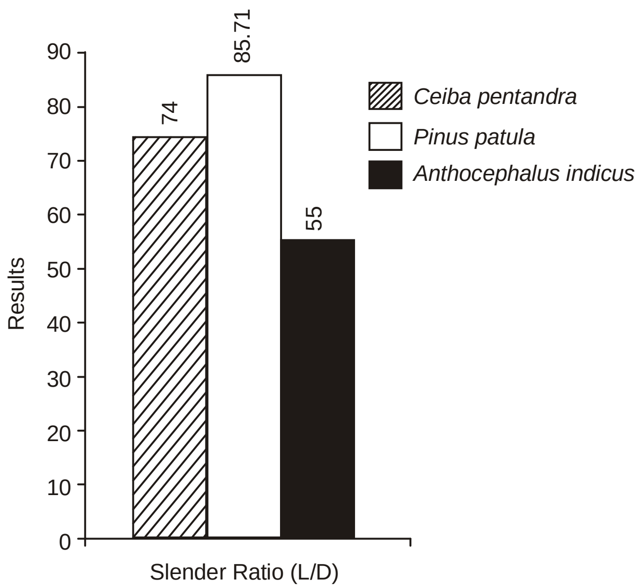

Fig.6. Comparison of slender Ratio by physico analysis data of Fibre of *Ceiba pentandra, Pinus patual* and *Anthocephalus indicus* wood dust.

CONCLUSION

Wood of *Ceiba pentandra* is fast growing, easy in debarking and chipping. It contains low molecular weight compounds and polysaccharides. Pentosan content of *Ceiba pentandra* wood is of higher value, it is favourable for dense and good pulping. The physico analysis data revealed that fibre of low density wood is ribbon like and flexible.

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