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SUITABILITY OF SOME NON-COMMERCIAL FAST GROWING WOOD YIELDING TREES GROWING IN AZAD KASHMIR FOR THE PRODUCTION OF PULP AND PAPER

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Abstract

Wood fiber dimensions and chemical constituents were investigated in three fast growing trees viz. Desi kikar (*Robinia pseudoacacia*. L), Drave (*Ailanthus atissima* Mill (Swingle) and Safeda (*Populus ciliata*, Wall ex Royle) to see their suitability for the production of pulp and paper. The average fiber length, fiber diameter, fiber wall thickness and Runkel's ratio for *Robinia pseudoacacia* were 0.99mm ± 0.1, 21.15μ ± 2.71,2.08μ ±0.8 and 0.21 respectively. The corresponding values for *Ailanthus altissima* were 0.89mm ± 0.2, 21.05μ ± 1.88;2.43μ ± 0.3 and 0.30 respectively and that for *Populus ciliata* were 0.96mm ± 0.66, 19.78 μ ± 2.5; 3.02 μ ±0.04 and 0.24 respectively. The amount of lignin, holocellulose and alphacellulase content in *Robinia pseudoacacia* were in the order of 23.12%, 73.18% and 38.16% respectively. The corresponding values for *Ailanthus altissima* were 22.19%, 80.12% and 39.21% respectively and that for *Populus ciliata* were 24.16% 69.10% and 37.20 respectively.The high amount of extractives and the low amount of holocellulose and alphacellulose content in the wood, when compared with other type of woods, suggest that relatively low pulp yield can be obtained from them. Similarly short length and diameter of fibers claim that these woods are unsuitable for making strong paper. However Runkel's ratio suggest that a well bonded sheet could be expected from all these woods if used in mixed form with other type of long fibered soft woods.

Introduction

Wood is serving mankind since ages in various disciplines. Now a day its major use is in the production of pulp and paper. Due to the shortage and very high cost of long fibered softwood in Pakistan, which are commonly used for the production of good quality paper, we are to search for good quality fast-growing hard woods to fulfill the growing demand.

There are two parameters generally used to test the wood for the production of pulp and paper. They are fiber morphology and chemical composition. In the light of these two important parameters, three fast growing hardwood trees viz. *Robinia pseudoacacia Ailanthus altissima* and *Populus ciliata* are tested for their use in the production of pulp and paper

Materials and methods

Wood samples for the present study were collected from three adult trees viz: *Robinia pseudoacacia, Ailanthus altissima* and *Populus ciliata*, growing in different areas of Muzaffarabad, for investigation of anatomical characteristics and chemical composition. The following procedures were adopted.

Anatomical characteristics: Small disc about 2.5cm thick was cut from each billet of the stem. Bark was first removed from this disc. Small blocks measuring 2x2cm were cut from each disc of the tree. These blocks were boiled in water till fully water soaked. From these blocks free hand cross sections were cut with sharp razor blade. After having stained in safranin, the sections were dehydrated in absolute alcohol and were permanently mounted in Canada balsam on glass slides. From

these slides, fiber diameter, fiber lumen diameter and cell wall thickness were determined. For the measurement of fiber length, matchstick size splinters were cut from each block. Few splinters were placed in test tube and were boiled in 20% nitric acid with the addition of small amount of potassium chlorate, until fibers were torn apart and started separating from each other. The boiled material was then washed with water. A small amount of material containing fibers was placed on the glass slides and observed under the microscope. Fiber length was determined with the help of eyepiece micrometer.

Chemical methods: Wood chips were made with sharp knife from wood samples and ground in blender to make saw dust which was passed through 40 mesh (420μ) but retained on 60 mesh (250 μ). British standard sieve was used for chemical analysis. Alcohol-benzene extraction was done by giving six hour treatment of 95% ethyle alcohol-benzene mixture (1.2 v/v) in the soxhlet extractor. The wood samples were filtered and dried at 105C°±3. Hot water extraction was done at 100C° for three hours. The extracted wood meal was brought to constant moisture content before weighing and reported as percentage of initial oven dry weight of alcohol-benzene extracted wood. Estimation of holocellulose, alphacelulose and lignin content was carried out from extractive free wood. The lignin content was determined by TAPPI Standard Method T-13-os-54. For extraction of holoecllulose, modified chlorite method of Wise et al (1946) developed by Erickson (1962) was used. Six, one hour sodium chlorite treatment was given to fully delignify the wood. The holocellulose thus obtained was subsequently used for alphacellulose determination, using the method of Siddiqui (1976).

Results and discussion

Wood fiber characteristics and chemical composition are two important parameters which determine its suitability as raw material for the production of pulp and paper. The extractive content has a direct effect on the pulp yield, a high content reduce pulp yield. On the other hand holocellulose, alphacelluose and lignin content are mainly related to pulping behaviour, whereas morphology of fiber affects paper strength.

Fiber dimensions: Mean values of fiber dimension for each tree are given in Table1. The average fiber length is maximum in *Robinia pseudoacacia*, which is 0.99mm (range 0.55-1.25mm) than that of *Ailanthus altissima,* average 0.89mm (range 0.51 1.2mm) and *Populus ciliata*, average 0.96mm (range 0.53-1.2mm). The fiber diameter is nearly the same in *Robinia pseudoacacia* (21.15u±2.71) and *Ailanthus altissima* (21.05u±1.98), whereas, it is minimum in *Populus ciliata* (19.78u±2.53). The average cell wall thickness is maximum in *Poplus ciliate* (3.02u±0.4) and nearly the same in R*obinia pseudoacacia*(2.08u±0.8) and *Ailanthus altissima* (2.43u±0.3). These values generally agree with the earlier reported values for these species (Ahmad, 1992). Comparing the fiber length, diameter and cell wall thickness of *Robinia pseudoacac*ia, *Ailanthus altissima* and *Populus cilata*, with the corresponding average values of softwoods and hardwoods as reported by Sadawarte and Prasad, 1979; Kayama 1979 (Table-1), the fibers of *Robinia pseudoacacia*, *Ailanthus altissima* and *Populus ciliata*, have shorter length and samaller diameter. Similarly the cellwall is very small when compared with that of

tropical hardwoods (Table-1). In view of the short length and smaller diameter of fiber, it can be suggested that the woods of *Robinia Psudoacacia*, *Ailanthus altissima* and Populus ciliata, may not be suitable for making strong paper. However while comparing the Runkel's ratio of these trees with that of chir pine (Siddiqui, 1981); it could be suggested that well bonded sheet could be expected from these trees.

Chemical composition: Alcohol-benzene extractives in the wood of *Robinia pseudoacacia* were 20%, in *Ailanthus altissima* were 19.89% and in *Populus ciliata* were 21.6%. Hot water extractives *in Robinia pseudoacacia* were 21.64%, in *Ailanthus altissima* were 18.6% and *Populus ciliata* were 20.6%. The holocellulose content in *Robinia pseudoacacia* was 73.18%, alpha cellulose 38.16% and lignin 23.12%. In the wood of *Ailanthus altissima*, the holocellulose content was 80.12%, alphacellulose, 39.21% and lignin 22.19%. In the wood of *Populus ciliata* the holocellulose centent was 69.10%, alphacellulose 37.80% and lignin 24.16%. The extractive contents directly affect the pulp yield. Wood chemical characteristics like low alcohol-benzene extractives, high cellulose quantity and low lignin contents are regarded favourable characteristics for the production of pulp and paper (Kayama, 1979). Comparing the values determined for *Robinia pseudoacacia*, *Ailanthus altissuma* and *Populus ciliata* with the corresponding average values for the tropical and hardwood (Kayama, 1979), conifers and fast growing angiosperm of Pakistan (Mahmood, 1983 & Mehmood & T. Mahmood 1985), it can be concluded that *Robinia pseudoacacia, Ailanthus sltissima* and *Populus ciliata* woods have a high content of water and alcohol benzene extractives, while holocellulose contents are comparable with other woods and the lignin and the alphacellulose contents are lower than that of the reported woods (Table-2).

Considering the chemical contents of *Robinia pseudoacacia, Ailanthus altissima* and *Populus ciliata* woods, it becomes clear that due to higher quantity of extractives, relatively low pulp yield can be expected from these trees. The short length and smaller diameter of the fiber have rather render these woods to be unsuitable for making strong paper. However on the basis of Runkel's ratio, which is comparable with that of chir pine (Siddiqui, 1981), a well bonded sheet could be expected from these woods. It is suggested that if the pulp obtained from these woods are used in mixed form with other type of long fibered soft woods, a well-bonded strong paper can be obtained.

Table 1. Fiber characteristics of *Robinia pseudoacacia, Ailanthus altissima* and *Populus ciliata* as compared with some softwoods, hardwoods and tropical hardwoods.

Source	Softwood Sadawarte & Prasad (1979)	Hardwood Sadawarte & Prasad (1979)	Tropical hardwood Kayama (1979)	*Robinia pseudoacacia*	*Ailanthus altissima*	*Populus ciliata*
Fiber length (mm)	3.6	1.2	1.45	0.99	0.89	0.96
Fiber diameter (Microns)	40.0	28.0	29.9	21.15	21.05	19.78
Cell wall thickness (Microns)	--	--	--	2.08	2.43	3.02
Runkel's ratio	--	--	--	0.21	0.30	0.24

Table 2. Chemical contents of *Robinia pseudoacaia, Ailanthus altissima* and *Populus ciliata* in comparison with some softwoods hardwoods, tropical hard woods, conifers and some fast growing angiosperm of Pakistan.

Source	Tropical hardwoods Kayama (1979)	Japanese hardwoods Kayama (1979)	Conifers of Pakistan Mehmood & T.Mehmood (1985)	Fast growing angiosperm of Pakistan Mehmood (1983)	*Robinia Pseudoacacia*	*Ailanthus altissima*	*Populus ciliata*
Soluble in hot water	4.5	5.2	3.5	3.4	21.64	18.60	20.60
Soluble in alsohol benzene	--	4.9	7.5	4.6	20.00	19.89	21.60
Holocellulose	77.8	69.9	69.1	74.4	73.18	80.12	69.10
Alphacellulose	48.1	46.3	44.1	43.9	38.16	39.21	37.80
Lignin	23.4	30.0	32.9	25.7	23.12	22.19	24.16

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