A STUDY ON FIBER MORPHOLOGY OF SOME HARDWOOD SPECIES GROWING IN LALKOO, SWAT FOR ASSESSING THEIR SUITABILITY FOR PULP AND PAPER MANUFACTURING

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ABSTRACT

This study was carried out to evaluate the suitability of some hardwood species growing in Lalkoo, Swat based on morphological characteristics of wood fiber. For this purpose, wood samples were collected from local depots and wood fibers from each species were separated adopting standard laboratory procedures. Results showed that Walnut *(Juglans regia)* fibers were comparatively longer in llength followed by Pohu *(Parotia jacouemontiana)*, Mulberry *(Morus alba)*, Black locust *(Robinia pseudoacacia)*, Himalyan yew *(Taxus wallichiana)*, Indian willow *(Salix tetrosperma)*, Brown Oak *(Quercus semicorpifolia)*, Tree of Heavan *(Allianthus altisimia)* and Himalayan poplar *(Populus ciliate)* while fibers of *Salix tetrosperma* were found with small diameter followed by *Ailanthus altisma*, *Quercus semicorifolia* , *Morus alba*, *Juglans regia*, *Populus ciliate*, *Parotia jacouemontiana*, *Taxus wallichiana* and *Robinia pseudoacacia*. The fibers wall was found comparatively thin in *Populus ciliate* followed by *Taxus wallichiana*, *Ailanthus altisma*, *Quercus semicorifolia*, *Salix tetrosperma*, *Juglans regia*, *Morus alba*, *Parotia jacouemontiana* and *Robinia pseudoacacia* while Runkel ratio was found comparatively very low in *Morus alba* 0.12 followed by *Ailanthus altisma* 0.22, *Robinia pseudoacacia* 0.24, *Taxus wallichiana* 0.50, *Populus ciliate* 0.62, *Juglans regia* 0.86, *Quercus semicorpopifolia* 0.94, *Parotia jacouemontiana* 0.96 and *Salix tetrosperma* 1.00. Based on the results it was concluded that all wood species except *Salix tetrasperma* can be selected for manufacturing of pulp and paper products.

Keywords: Fiber morphology, Hardwoods, Lalkoo-Swat.

INTRODUCTION

Pakistan is one of the largest countries that import raw pulp and ready-made paper and use huge amount of foreign reserve on this important commodity (Afshan *et al*.2022). However, Pakistan is an agricultural country where fertile land, variety of tree species and water resources are available to produce the best quality wood for pulp and paper and furniture industry (FAO, 2002). Paper industry has special significance in economic structure of Pakistan because of the two main reasons. First, Pakistan is predominantly an agrarian economy, offering suitable raw materials base. Second, Pakistan has a large and growing market size having a population of over 180 million (Rehman, 2015).

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These factors are translating into consistent demand for paper industries output. Despite of current challenges faced by the country; it is a renowned fact that paper industry of Pakistan still has huge potential to develop. At Present Pakistan is highly independent on the import of a variety of paper products in general and raw material as pulp and wastepaper because wood is not being unutilized as raw material for paper manufacturing in industry (SECOM, 2012). Therefore, it is imperative to determine the suitability of different locally grown wood species for their use in pulp and paper industries for manufacturing of various paper products.

Fiber is the basic component material in paper making on which the paper properties depend. Fiber morphological characteristics play a key role to find out the suitability of a wood species for pulp and paper manufacturing (Sara, 2015). Assessment of morphological and anatomical characteristics is necessary for better utilization of the wood fiber (Riki *et al*., 2019). Wood fiber is the most important element of the pulp and paper manufacturing industry. Moreover, wood fiber determines the resilience and resistance of wood against the insect attack, weathering, and seasoning (Ritter *et. al*., 2011).

Keeping in view of the above scenario, this study was conducted to assess morphological and anatomical characteristics for determination of technological properties of wood fiber of different tree species.

MATERIALS AND METHODS

Research material in the form of logs were collected/procured from local Depots of Lalkoo, Swat. From each log of each species wood discs were cut down and samples in the form of blocks were prepared. From each block of each species, wood samples in the form of matchsticks were prepared and poured into test tubes and labeled properly. Then, 5 ml of 20% Nitric acid and 2mg of Potassium Chlorate were added and the test tubes were kept for maceration in beakers containing water (Anon., 1974). The beakers were put onto hot plate at 100 ^{0}C for 6-8 hours. After maceration, the pulpy material was repeatedly washed with water using filter paper until solution of chemicals completely removed. The mashie material of each wood samples was saved in test tubes for studying morphological parameter (Anon., 1971). Wood morphological characteristics were studied under microscope and statistical analysis was carried out with Microsoft Exell 2010.

RESULTS AND DISCUSSION

Walnut *(Juglans regia)* fibers were found comparatively very long i.e., mean value (mv) 1364.82±230.24µ long (918-1897µ) followed by Pohu *(Parotia jacouemontiana)* 1341.35±280.60µ long (886.05-2187.77 µ), Mulberry *(Morus*

alba) 1097±257.67µ long (137.26-1541.59µ), Black locust *(Robinia pseudoacacia)* 1074.83±314.38µ long (119.45-1798.08 µ), Himalyan yew *(Taxus wallichiana)* 1025.54±276.04µ (239.00-1770.00µ), Indian willow *(Salix tetrosperma)* 835.65±152.06 µ long (531.21-1144.09µ), Brown Oak *(Quercus semicorpifolia)* 738.67±214.29µ long (312.37-1202.22µ), Tree of Heavan *(Allianthus altisimia)* 639.75±188.14 µ long (59.38-950.20 µ) and Himalayan poplar *(Populus ciliate)* 490.89±170.23µ long (306.78-852.26µ). According to Wimmer *et .al*., 2002, the fiber with longer length, determines the quality of pulp and paper flexibility, and resilience of the wood. The wood fibers of Walnut were found comparatively longer in length which shows that walnut may produce better quality pulp and paper, wood articles with better flexibility and resilience followed by Pohu *(Parotia jacouemontiana),* Mulberry *(Morus alba)*, Black locust *(Robinia pseudoacacia)*, Himalyan yew *(Taxus wallichiana)*, Indian willow *(Salix tetrosperma)*, Brown Oak *(Quercus semicorpifolia)*, Tree of Heavan *(Allianthus altisimia)* and Himalayan poplar *(Populus ciliate)* wood.

Ajala and Noah, 2019 reported that fibers of small diameter may produce a good quality of pulp and paper and its utilization may increase the quality of paper. Moreover, small diameter of fiber may increase the frequency of fibers in wood that may give a good strength and flexibility to the wood articles. Keeping in view, it was found that fibers of *Salix tetrosperma* were found with small diameter i.e., mean value 8.41±1.69µ long (5.43-12.41µ) followed by *Ailanthus altisma* 9.33±2.05µ long (6.07-14.51µ), *Quercus semicorifolia* 9.56±1.73µ long (7.07-14.17µ), *Morus alba* 13.50±2.86 µ long (9.48-20.74µ), *Juglans regia* 15.71±4.17µ (5.43-26.82 µ), *Populus ciliate* 16.44±4.77µ long (7.08-26.48µ), *Parotia jacouemontiana* 17.80±4.44 µ long (11.45-29.36µ), *Taxus wallichiana* 20.79±5.28µ long (10.90-29.19µ) and *Robinia pseudoacacia* 40.87±11.62µ long (19.20-71.46µ).

Fiber wall thickness shows the strength, rigidity, and a resistance against the fungal and insect attack of the wood (Riki, 2019). Fiber wall was found comparatively thin in *Populus ciliate* with mean value 3.12±0.81 *µ* long (1.63-4.75 *µ*) followed by *Taxus wallichiana* 3.46±1.05 *µ* long (1.33-5.70 *µ*), *Ailanthus altisma* 3.83±0.90 *µ* long (0.90-23.57 *µ*), *Quercus semicorifolia* 4.54±0.58 *µ* long (3.37-5.67 *µ*), *Salix tetrosperma* 5.05±1.54 *µ* long (2.71-8.58 *µ*), *Juglans regia* 6.79±1.54 *µ* long (4.37-10.30 *µ*), *Morus alba* 6.91±1.26 *µ* long (4.53+9.78 *µ*), *Parotia jacouemontiana* 10.06±2.39 *µ* long (6.07-15.21 *µ*) and *Robinia pseudoacacia* 17.95±4.16 *µ* long (10.06-31.25 *µ*).

Runkel, 1949 and Ademiluyi and Okeke,1977 described that Runkel ratio determines the quality of wood fiber for pulp and paper quality. The Runkel ratio less than 1.00 is considered better for pulp and paper making industry due to better beating capacity. Runkel ratio was found comparatively very low in *Morus alba* 0.12 followed by *Ailanthus altisma* 0.22, *Robinia pseudoacacia* 0.24, *Taxus*

wallichiana 0.50, *Populus ciliate* 0.62, *Juglans regia* 0.86, *Quercus semicorpopifolia* 0.94, *Parotia jacouemontiana* 0.96 and *Salix tetrosperma* 1.00.

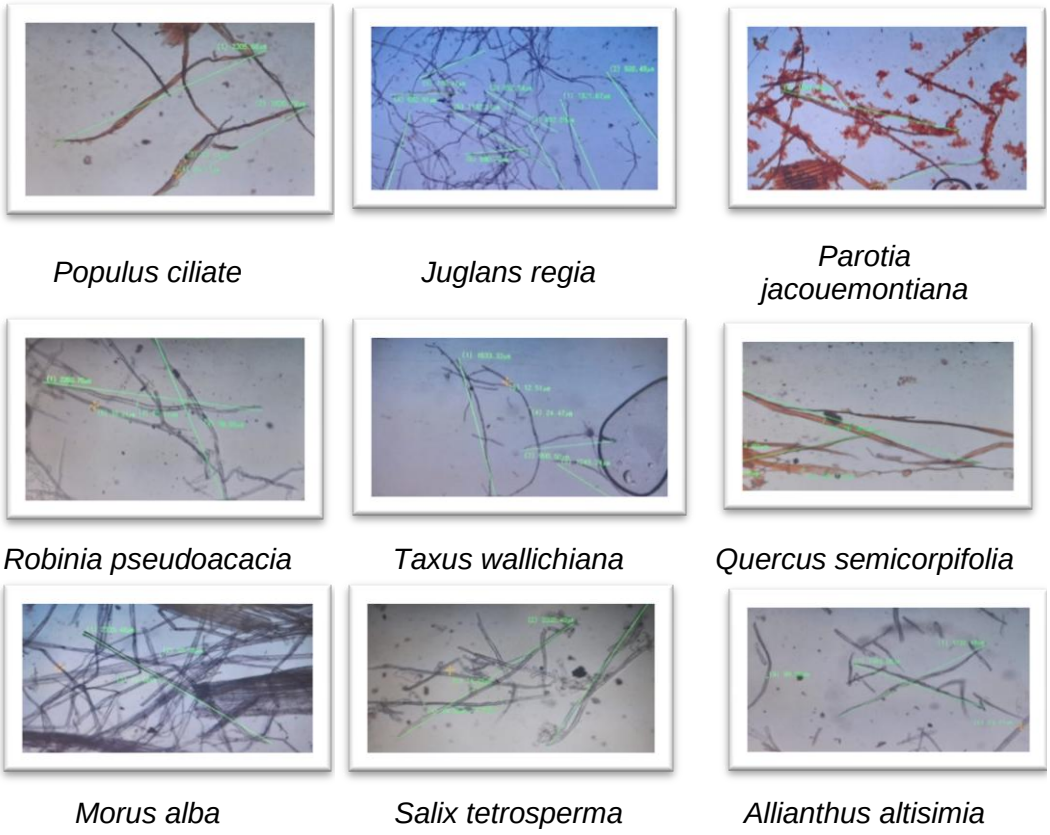

Fig.1. Wood Fibers of Studied Species

CONCLUSIONS

In conclusion, the research paper has provided valuable information regarding potential of various wood species for manufacturing of pulp and paper. The results indicate that all wood species except Red Willow (*Salix tetrosperma)* collected from Lalkoo, Swat have good potential for manufacturing of pulp and paper products. However, the quality of products may vary in view of the of fiber morphological characteristics.

Table 1. Descriptive statistics of fiber length of the selected species

S#	SPP. NAME	FIBER LENGTH (µ)					FIBER DIAMETER (µ)					FIBER WALL THICKNESS (µ)					Runkle Ratio
		MV	SD	CV	MIN	MAX	MV	SD	CV	MIN	MAX	MV	SD	CV	MIN	MAX	
1	*Allianthus altisimia*	639.75	188.14	29.40	59.38	950.20	9.33	2.05	22.06	6.07	14.51	3.83	0.90	23.57	2.21	5.71	0.22
2	*Juglans regia*	1364.82	230.24	16.87	918.00	1897.00	15.71	4.17	26.53	5.43	26.82	6.79	1.54	22.69	4.37	10.30	0.86
3	*Morus alba*	1097.00	257.67	23.48	137.26	1541.59	13.50	2.86	21.17	9.48	20.74	6.91	1.26	18.21	4.53	9.78	0.12
4	*Parotia jacouemontiana*	1341.35	280.60	20.92	886.05	2187.77	17.80	4.44	24.96	11.45	29.36	10.06	2.39	23.76	6.07	15.21	0.96
5	*Populus ciliate*	490.89	170.23	34.68	306.78	852.26	16.44	4.77	29.02	7.08	26.48	3.12	0.81	26.03	1.63	4.75	0.62
6	*Quercus semicorpifolia*	738.67	214.29	29.01	312.37	1202.22	9.56	1.73	18.16	7.07	14.17	4.54	0.58	12.83	3.37	5.67	0.94
7	*Robinia pseudoacacia*	1074.83	314.38	29.25	119.45	1798.08	40.87	11.62	28.43	19.20	71.46	17.95	4.16	23.16	10.06	31.25	0.24
8	*Salix tetrosperma*	835.65	152.06	18.19	531.21	1144.09	8.41	1.69	20.08	5.43	12.41	5.05	1.30	25.86	2.71	8.58	1.00
9	*Taxus wallichiana*	1025.54	276.04	26.92	239.00	1770.00	20.79	5.28	25.42	10.90	29.19	3.46	1.05	30.39	1.33	5.70	0.50

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