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Chemical and Physical analysis of *Morus Nigra* (Black Mulberry) for its pulpability

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ABSTRACT: Chemical constitution of the fibrous material is not the only deciding factor for determining the nature of the pulp that may be made out of it. Much will depend upon the morphological properties, anatomical structure of the raw material and physical properties, in determining the yield and quality of the pulp [4]. The study of wood of *Morus Nigra* was analyzed for the determination of its constituents and its suitability for pulp and paper manufacture. Physical and chemical analysis of the *Morus Nigra* species needs special attention while exploring its pulpability and *Morus Nigra* is analyzed by using TAPPI procedures.

Keywords: Pulpability; Fibre Length; Luman Width; Acetyl Content.

INTRODUCTION

Paper is the felted sheet of fibers found on a fine screen from a water suspension. Pulp is the fibrous raw material for paper making. Wood is the principal source of cellulose for making paper. As with the expansion of paper industries in the country, pulp containing plants are being used to an appreciable extent. The world wood fiber [3] is the original source of over 98% of the fibrous component of paper in the world. Mulberry is a small deciduous tree growing to 10-13 meter tall. The leaves are 10-20 cm long and 6-10 cm broad. The most important use of mulberry is lies in rearing silk worms and the bark of the tree is used for paper manufacturing [5]. The physical parameter like basic density, fibre length, fibre diameter, lumen width, cell wall thickness, runkel ratio, shape factor and slenderness ratio of sample dust and its fibers are measured. The sample dust was analyzed for ash content, cold water and hot water solubility, alcohol-benzene solubility, alkali solubility, lignin content, pentosan content alpha, beta, and gamma-cellulose, holocellulose, acetyl content, methoxyl content and uronic anhydride content etc. For proximate composition analysis the TAPPI standard methods [6], Canadian standard methods [7] and Dore method were employed. The results of such analysis were compared with that of other woods.

MATERIAL AND METHODS

The *Morus nigra* logs were collected from different districts of Karnataka and Himachal Pradesh. The bark was removed manually and dried, debarked logs are prepared into chips of suitable size that remain between 20-25 mm hole diameter. The chips were grind and dust so obtained was passed through 40 meshes and retained on 60 meshes was collected.

The Physical characteristics like density, fibre length, lumen width and cell wall thickness of wood dust and its fibers are measured by TAPPI standard method [8] and Maceration method [9]. For the measurements of fibre length, fibre diameter, lumen width and cell wall thickness, *Morus nigra* samples were macerated in a solution containing 1:1, HNO_3 and $KClO_3$. For maceration, wood samples taken from three parts of each sample wood were chosen. A drop of macerated sample was taken on slide and fibre length, fibre diameter, lumen width and cell wall thickness were measured under a *Rheichert Visopan*

microscope. For measuring fibre properties, approximate 200 fibers were measured from ten slides and average readings were recorded.
For each determination of the wood dusts, samples of *Morus nigra* were collected and investigated separately for chemical analysis [10]. Similar investigation/test was performed for both the samples. The results were calculated on the basis of original moisture free dust.

RESULTS AND DISCUSSION

The results of physical analyses are recorded in Table-1 and Table-2 and shown graphically in Figure-1.

Table 1: Physical analysis data of *Morus nigra* wood dust sample.

Wood Dust	*Morus nigra*
Basic Density of Wood (g/cm^3)	0.50
Average Fibre Length 'L'(mm)	1.28
Fibre Diameter 'D' (mm)	0.023
Lumen Width 'l' (mm)	0.0142
Cell Wall Thickness 'W' (mm)	0.0036

Table 2: Calculation of fibre dimensions of *Morus nigra* wood dust sample.

Wood Dust	*Morus nigra*
Runkel Ratio (2W/l)	0.5070
Slenderness Ratio (L/D)	55.65
Shape Factor ($D^2 - l^2/D^2 + l^2$)	0.4480

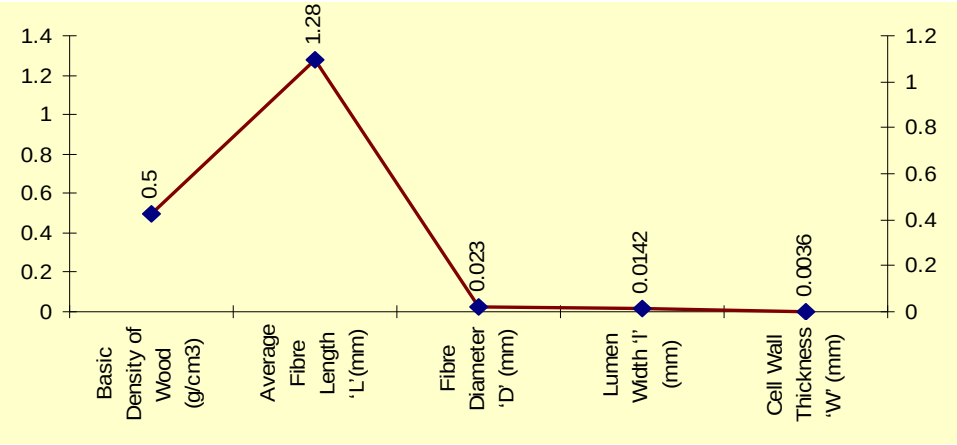

Figure 1: Physical analysis data of *Morus Nigra* wood dust sample.

Physical analysis of the *Morus nigra* samples collected gives an idea about the morphology of wood, fibre characteristics and pulping properties. The basic density of *Morus nigra* is 0.50. The fiber length, fibre

diameter, lumen width and cell wall thickness of *Morus nigra* found 1.28 mm, 0.023 mm, 0.0142 mm and 0.0036 mm respectively (Table-1 and Figure-1). The properties of fibre length influence the tensile and bursting strength and slightly affect the folding endurance. It is an observation that greater the fibre length, higher will be the tearing resistance of paper. On the other hand, longer fiber tends to give a more open and less uniform paper sheet structure. The value of fibre diameter affects the tear resistance as the ratio of fibre length to the fibre diameter increases the tear resistance. Another observation is that fiber lumen width affects the beating of pulp. Larger the fiber lumen width better will be the beating of pulp, because of penetration of liquid into empty space between the fibers. The values of cell wall thickness do not show large variation as it is ranging from 0.0035 to 0.0037 mm. The value of cell wall thickness affects the runkel ratio and wall fraction. It is also clear in case of long fiber pulp, an increase in cell wall thickness is usually accompanied by an increase in tearing strength, this relationship necessarily holds true for paper made from short fiber pulp. It is also observed that, lower the wall fraction, better be the plasticity of the fiber. It is further clear that the wall thickness did not vary appreciably with variation in species.

Pulp strength properties are usually favorable when value of runkel ratio is below the standard value. It is observed that higher runkel ratio fibers are stiffer, less flexible and form bulkier paper of lower bonded area than the lower runkel ratio fibers. The above physical or morphological data reveals that higher the value of fiber length/width ratio, greater will be the fiber flexibility and better be the chances of forming well bonded paper. Similarly, an increase in the rigidity of fibers results in a decrease in fiber bonding. The above observed values of physical analysis are the indicators of fiber dimension and it must be understood that fiber of high density are cylindrical and rigid, where as those of low density woods are ribbon like and flexible [11 & 12].

The proximate chemical analysis of wood is generally carried out by well established standard methods. Chemical analysis gives an idea about the category to which the wood belongs i.e. softwood, hardwood and agricultural residues etc. The complete proximate chemical analysis results of *Morus nigra* wood dust was recorded in Table-3 and graphically represents in Figure-2.

Table 3: Chemical analysis data of *Morus nigra* wood dust sample (on O.D. % basis).

Wood Dust	***Morus nigra*** (in %age)
Ash Content	0.85
Cold Water Solubility	3.90
Hot Water Solubility	4.98
1% NaOH Solubility	18.00
Alcohol-Benzene Solubility	2.60
Ether Solubility	0.96
Pentosan Content	15.20
Lignin Content	21.42
Holocellulose Content	69.15
Alpha-Cellulose Content	45.00

Beta-Cellulose Content	13.50
Gamma-Cellulose Content	17.48
Acetyl Value	2.27
Uronic Anhydride Content	2.88
Methoxyl Value	4.78

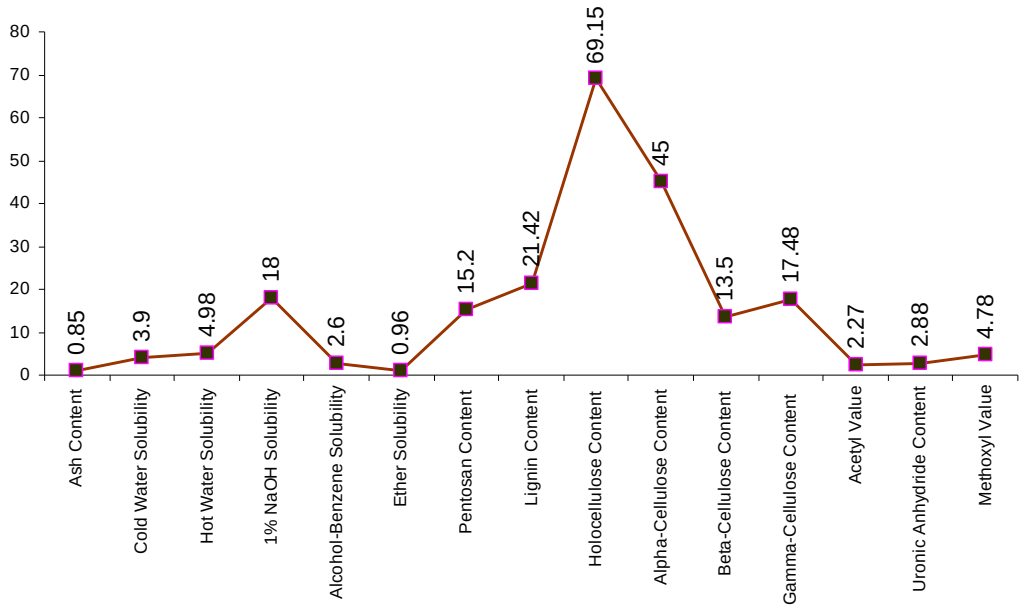

Figure 2: Chemical analysis data of *Morus nigra* wood dust sample.

CONCLUSION

From the results and discussion it may be concluded that physical analysis of the samples collected give an idea about the morphology of wood samples, fiber characteristics and pulping properties. The basic density or the specific gravity is the index of fiber collapsibility and is likely to give indication of the pulping qualities, if other factors considered being the same. The values of physical analysis like basic density, fiber length, fiber diameter, lumen width, cell wall thickness, runkel ratio and slenderness ratio indicate that the species *Morus nigra* is useful in pulp and paper manufacturing purpose and the above observed values of physical analysis indicate that *Morus nigra* is hardwooden in nature. The results of chemical analysis also suggested the nature of pulp and give an idea about the category to which wood belongs. The value of uronic anhydride (acid) observed in the *Morus nigra* (hardwoody) is higher in comparison to *Ceiba pentandra* (softwoody) [12] samples, which indicates the presence of carboxylic group in hemicellulose. The lower values of hot water solubility, alkali solubility, lignin value and higher holocellulose & cellulose content of *Morus nigra* are more favorable for good quality of pulp.

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