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Variation in Physico- Chemical Properties of (*Diospyros montana* Roxb.) in Himachal Pradesh

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***Abstract*:** The present study was confined to 19 mother trees of *Diospyros montana* Roxb. distributed in Solan districts of Himachal Pradesh. Mother trees were selected from Nalagarh and Baddi area of Solan district. Physico- chemical properties were studied by collected wood samples from the 19 mother trees. Specific gravity was recorded maximum for mother trees 7 and 2 (M_7andM_2) of Nalagarh area, fiber length and fiber diameter was recorded maximum for mother trees 8 and 19 (M_8 and M_{19}) and holocellulose content was maximum for mother tree 15 (M_{15}) of Baddi area. Maximum moisture Content (MMC) showed significant correlation with specific gravity and alcohol- benzene extractives. Fiber length is correlated with fiber diameter. 89.88% of variation was showed by five PCA for wood parameters.

Keywords: Variation, Diospyros, Repeatability, PC clusters, Correlation

India is blessed with a wide range of vegetation types, from tropical to subtropical, temperate to subalpine, and alpine. Within an ecosystem, forests play both a protective and productive role. The protective role of the forest is limited to the production of timber, but it also produces non-timber forest products, which are derived from over 3,000 species. Non-timber forest products (NTFPs) are biological products other than timber that are harvested by humans from wild biodiversity in both natural and artificial environments (Sardeshpande and Shackleton 2019). Due to inadequate understanding of their intended uses, many products are either not fully extracted or are thrown away. Most species have had little research done on their biodiversity. but plants or their products are traded, even their identification and classification are sometimes inadequate, creating significant confusion. *Diospyros montana* (family Ebenaceae), commonly known as Bombay ebony found in some parts of Solan, Sirmour and Una district. It is a small deciduous tree upto 20 m high with spiny trunk and branches. It is a dioecious (separate male and female plants) tree species. It is commonly known as ebony tree because of its hard, heavy and dark timber. The wood of *Diospyros* isgrey, often tinged with yellow or brown, streaked with narrow patches of darker colour, especially towards the centre, but there is no regular ebony heartwood. The wood is soft to moderately hard and durable

Theplant populations in the wild display complicated patterns of diversity, which makes it essential to choose superior stands for breeding (Gupta and Sehgal 2000). Variability in important traits is critical to the evolution of a species. For a species to adapt and become better through breeding programs, variations are necessary. Tree breeding cannot raise the quality if there is no variation in the trees. Determining the amount, source, and kind of variation present in the target species is the first step in any improvement endeavor. Three characteristics set trees apart: their varied surroundings, their individual peculiarities, and the way their genotype interacts with their growing environment. The study was conducted to observe the variation in physico- chemical properties of *Diospyros montana* Roxb.

MATERIAL AND METHODS

Keeping in view the importance of wood of *diospyros* samples were collected from 19 mother trees selected in Nalagarh and Baddi area of Solan district of Himachal Pradesh (Table 1). After collection, drying and sawing of wood samples the following physical, anatomical and chemical wood properties were recorded. Bark percent was calculated as D.O.B.- D.U.B./ D.O.B.*100. D.O.B = Diameter over bark and D.U.B = Diameter under Bark. Wood percent was calculated as D.O.B.- 2*bark thickness/ D.O.B.)*100. The moisture per cent of the samples was calculated by using method given by Desch and Dinwoodie (1996) i.e. Mi_{ni}-M_{od}/ M_{od}*100.

Mi_{ni} is initial weight of samples (g) and M_{od} is oven dried weight of samples (g). Maximum moisture content (MMC) of wood samples were determined (BIS 1986) i.e. Mm- Mo/ Mo*100, where, Mm is Saturated weight of wood samples (g). The specific gravity of the samples were determined by maximum moisture content method (Smith 1954) -

$$= \frac{1}{\frac{Mm - Mo}{Mo} + \frac{1}{GS}}$$

Where,

Mm = Fresh weight of the sample

Mo = Oven dried constant weight of sample.

GS = Average density of wood substance a constant having value 1.53.

The fiber dimensions were determined by macerating the wood shavings in Jeffery's solution, i.e. 10 per cent chromic acid and 10 per cent nitric acid, for 48 hours (Pandeya et al 1968). The cold and hot water soluble extractives were determined by employing the T1m 59 methods (Anonymous 1959a). Alcohol benzene extractives, Kalson-lignin content and holocellulose were determined by using the T6m 59 (Anonymous 1959b), T12m 59 (Anonymous 1959c) and T9m 54(Anonymous 1959d) methods respectively. The experimental data of all the tree characters studied were subjected to the statistical analysis for proper interpretation. The data was analyzed statistically using Random Nested Model as follows:

= μ + + +

Where:

μ = grand mean, p_i = effect of ith natural population (i=1,2.....p) m $(p)_{j(i)}$ = the jth mother tree effect within each ith natural population e_{ijk} = the interaction of the kth observation and jth mother tree in the ith natural population

Repeatability

Genotype repeatability =

Where, = Genotype variance, = Within genotype variance

Heritability in percentage was calculated as suggested by Burton and De-Vane (1953) and Johnson et al (1955). The expected genetic advance at 5 per cent selection intensity was calculated as suggested by Lush (1940) and further used by Burton and De-Vane (1953) and Johnson et al (1955). Genetic gain was worked out following the method suggested by Johnson et al(1955). Correlations were computed to examine inter-character relationships among different wood parameters .Principal component and cluster analysis were investigated by principal component analysis (PCA). PCA was performed using JMP pro 10software. Cluster analysis was also performed to cluster genotypes into similarity groups using the method of UPGA (Unweighted Pair Group Average) using ward method (Ward 1963).

RESULTS AND DISCUSSION

In physical properties of wood mother tree 11(M_{11})from Baddi showed the maximum wood percent (WP) of 97.14% and minimum (88.68 %) was for M_2 (Table 2). Maximum bark percent (BP) was for M_2 (11.32%) and minimum (2.86%) was recorded for M_{11}. M_2 showed the highest moisture content (MC) (81.92%) where and lowest (32.29%) moisture content (MC) was for M_1. The highest maximum moisture content (MMC) of 163.84% was observed for M_2 and lowest (64.58) maximum moisture content was for M_1. However specific

Table 1. Physical description of mother trees

Sites	Mother trees	Mother trees code	Altitude (feet)	Latitude (n)	Longitude (e)
Nalagarh	1	M_1	1207	30°59'909"	76°44'713"
	2	M_2	1202	30°59'915"	76°44'710"
	3	M_3	1205	30°59'917"	76°44'712"
	4	M_4	1201	30°59'867"	76°44'660"
	5	M_5	1204	30°59'867"	76°44'655"
	6	M_6	1200	30°59'881"	76°44'646"
	7	M_7	1203	30°59'935"	76°44'742"
	8	M_8	1202	30°59'984"	76°44'778"
	9	M_9	1209	30°59'939"	76°44'762"
Baddi	10	M_{10}	1597	30°59'694"	76°44'634"
	11	M_{11}	1673	30°59'460"	76°44'625"
	12	M_{12}	1719	30°59'472"	76°44'769"
	13	M_{13}	1760	30°59'493"	76°44'965"
	14	M_{14}	1764	30°59'505"	76°44'978
	15	M_{15}	1775	30°59'509"	76°44'019"
	16	M_{16}	1859	30°59'668"	76°44'075"
	17	M_{17}	1859	30°59'673"	76°44'076"
	18	M_{18}	1862	30°59'675"	76°44'079"
	19	M_{19}	1869	30°59'680"	76°44'085"

gravity was maximum (0.81) for M_7 and minimum (0.44) for M_2.Maximum fiber length (0.71mm) was recorded for M_8 which was followed by M_{10}(0.70mm) and minimum (0.58mm) for M_{11}. Maximum and minimum fiber diameter was for M_{19} (13.82µm) and M_7(11.54 µm). Cold water-soluble extractives were maximum in M_2 and hot water-soluble extractives were by mother tree 16 (M_{16}). Mother tree 8 (M_8) of Nalagarh area showed maximum alcohol-benzene content.Maximum holocellulose and lignin content was by M_{15} and M_{13} of Baddi area.

The value of phenotypic coefficient of variation (55.11%) and genotypic coefficient of variation (33.02%) were maximum for bark percent (BP) and minimum for wood percent (WP) i.e., 4.40% and 2.63%, respectively. Repeatability coefficient was maximum (0.75) for fiber length and minimum for cold water solubility (Table 3). The genetic variance between and within populations was not measured accurately because genetic effects can't be isolated from environmental effects in natural populations when parental origin and environmental influences cannot be controlled. As a result, were unable to calculate the heritability coefficient at the population or individual tree level. In this case, use the repeatability coefficient, which may be considered as the top limit of the genetic-phenotypic variance relationship (Falconer and Mackey 1996). These coefficients also show the proportion of within-population variation that contributes to total variance and the proportion of between-tree variation that contributes to total population variation.

However, genetic gain percent was maximum (44.68%) for moisture content (MC) and minimum (3.25%) for wood percent. For the proper utilization of observed variation in a species, it is prerequisite to know the extent of variation and also that whether, it is due to the genetic or the environmental factors. Hence, information on variation in the desired parameters and their correlation is vital for any breeding programme .

Wood percent showed highly significant negative correlation with bark percent (-1.00). Bark percent showed negative correlation with hot water solubility (-0.46). Moisture content showed significant correlation with (MCC) maximum moisture content (1.00%), negative correlation with specific gravity. Hollcellulose content was highly significant and negative correlated with lignin content .Bisen et al (2018) observed that in *Cleistanthus collinus* (Roxb.), bark percent

Table 2. Variation in different wood properties

Mother trees	Wood percent (WP)	Bark percent (BP)	Moisture content (%) (MC)	Maximum moisture content (%) (MCC)	Specific gravity	Fiber length (mm)	Fiber diameter (µm)	Cold water soluble extractives (%)	Hot water soluble extractives (%)	Alcohol-benzene extractives (%)	Holocellulose content (%)	Lignin content (%)
M_1	91.21	8.79	32.29	64.58	0.77	0.64	12.18	7.63	8.25	9.30	77.50	13.2
M_2	88.68	11.32	81.92	163.84	0.44	0.64	11.97	9.00	5.75	7.00	72.00	21
M_3	89.47	10.53	45.31	90.62	0.65	0.59	11.76	7.46	6.58	6.43	74.17	19.4
M_4	96.87	3.13	62.59	125.17	0.53	0.59	12.04	5.96	9.00	7.87	71.75	20.38
M_5	95.41	4.59	32.49	64.99	0.66	0.60	11.97	8.71	8.17	6.87	77.25	15.88
M_6	89.63	10.37	31.56	63.11	0.73	0.69	13.04	6.87	8.67	9.27	77.42	13.31
M_7	92.38	7.62	27.83	55.66	0.81	0.65	11.54	8.37	5.33	8.73	76.33	14.94
M_8	93.41	6.59	48.09	96.17	0.67	0.71	12.11	7.04	10.08	9.50	68.50	22
M_9	89.40	10.60	33.44	66.89	0.77	0.69	12.47	7.58	9.50	8.23	79.17	12.6
M_{10}	95.77	4.23	47.47	94.94	0.63	0.70	13.11	6.12	8.42	7.53	80.42	12.05
M_{11}	97.14	2.86	37.16	74.33	0.73	0.58	13.18	6.92	7.50	6.47	79.67	13.86
M_{12}	92.03	7.97	69.05	138.11	0.50	0.66	12.68	6.50	7.25	6.87	56.58	36.55
M_{13}	89.03	10.97	47.95	95.90	0.63	0.68	13.11	6.42	5.67	6.10	63.83	30.07
M_{14}	94.80	5.20	54.89	109.78	0.57	0.67	12.11	6.88	8.50	7.80	81.92	10.28
M_{15}	89.24	10.76	64.36	128.72	0.52	0.63	13.25	7.83	6.08	7.37	85.33	7.3
M_{16}	95.86	4.14	56.98	113.97	0.56	0.69	12.47	6.92	10.67	7.73	78.67	13.6
M_{17}	96.82	3.18	40.87	81.74	0.68	0.62	12.61	6.54	9.17	6.77	69.33	23.9
M_{18}	92.97	7.03	48.91	97.83	0.63	0.67	12.61	8.62	8.75	7.80	69.50	22.7
M_{19}	89.54	10.46	52.66	105.33	0.59	0.67	13.82	8.62	8.92	6.80	72.58	20.62
CD (p=0.05)	5.37	5.37	16.89	34.12	0.12	0.03	1.12	2.35	2.42	1.79	11.93	12.24

was negatively correlated with hot water solubility and holocellulose content. Fiber length showed significant correlation with alcohol- benzene soluble extractives. Fiber width is negative correlated with alcohol- benzene soluble extractives (Table 4). Cold water-soluble extractives are negatively correlated with hot water-soluble extractives and hot water-soluble extractives showed positive correlation with alcohol-benzene soluble extractives. Alcohol benzene soluble extractives showed negative correlation with lignin content.

Total 89.88% variation was showed by first five components (Table 5). The first component explained 31.09% variation in moisture, maximum moisture content (0.89) and lignin content (0.63). The second component explained 20.98% of variation in which maximum was showed for bark percent (0.91), specific gravity (0.25) and cold-water solubility (0.62). 14.39% variation was showed by third component in which maximum was exhibited for fiber length (0.81), fiber diameter (0.28) and hot water solubility (0.47). The fourth component explained 13.56% of variation showed by holocellulose content. The fifth component explained maximum variation for alcohol- benzene

Table 3. Variability estimates, genetic parameters and repeatability coefficient of wood parameters

Parameters	Phenotypic coefficient of variation	Genotypic coefficient of variation	Repeatability coefficient	Genetic advance	Genetic gain (%)
Bark percent (BP)	55.11	33.02	0.36	3.01	40.75
Wood percent (WP)	4.40	2.63	0.36	3.01	3.25
Moisture content (MC)	34.70	27.43	0.63	21.54	44.68
Maximummoisture content (MCC)	34.70	27.43	0.63	43.07	44.68
Specific gravity	18.25	14.53	0.63	0.15	23.83
Fiber length	6.75	3.36	0.75	0.07	10.45
Fiber diameter	6.44	3.71	0.33	0.55	4.42
Cold water soluble extractives	20.28	6.13	0.09	0.28	3.82
Hot water soluble extractives	24.29	16.03	0.44	1.75	21.80
Alcohol- benzene extractives	17.78	10.67	0.36	1.00	13.20
Holocellulose content	12.15	7.29	0.36	6.70	9.02
Lignin content	51.85	31.64	0.37	7.19	39.77

Table 4. Estimation of correlation coefficients among different wood properties

Parameters	Wood (%)	Bark (%)	Moisture content (%)	Maximum moisture content (%)	Specific gravity	Fiber length	Fiber width	Cold water soluble extractives	Hot water soluble extractives	Alcohol-benzene soluble extractives	Holocellulose content	Lignin Content
Wood percent	1.00											
Barkpercent	-1.00**	1.00										
Moisture content	-0.13	0.13	1.00									
Maximum moisture content	-0.13	0.13	1.00**	1.00								
Specific gravity	0.05	-0.05	-0.96**	-0.96**	1.00							
Fiber length	-0.25	0.25	0.01	0.01	0.05	1.00						
Fiber width	-0.14	0.14	0.08	0.08	-0.12	0.25	1.00					
Cold water soluble extractives	-0.42*	0.42	-0.02	-0.02	0.03	-0.10	-0.17	1.00				
Hot water soluble extractives	0.46	-0.46*	-0.15	-0.15	0.10	0.34	0.10	-0.27	1.00			
Alcohol- benzene soluble extractives	-0.03	0.03	-0.34	-0.34	0.43	0.45	-0.30	0.01	0.37	1.00		
Holocellulose content	0.11	-0.11	-0.29	-0.29	0.25	-0.09	0.02	0.16	0.09	0.24	1.00	
Lignin content	-0.10	0.10	0.32	0.32	-0.30	0.02	0.02	-0.16	-0.14	-0.37	-0.99**	1.00

Table 5. Principal component analysis

Parameters	PC1	PC2	PC3	PC4	PC5
Bark percent	0.33	0.91	0.16	0.03	-0.05
Wood percent	-0.33	-0.91	-0.16	-0.03	0.05
Moisture content	0.89	-0.17	-0.07	0.38	0.15
Maximum moisture content	0.89	-0.17	-0.07	0.38	0.15
Specific gravity	-0.86	0.25	0.13	-0.38	-0.07
Fiber length	-0.05	0.2	0.81	0.39	0.03
Fiber diameter	0.16	0.02	0.28	0.23	-0.88
Cold water-soluble extractives	0.04	0.62	-0.35	0.05	0.24
Hot water-soluble extractives	-0.37	-0.5	0.47	0.35	0.07
Alcohol- benzene extractives	-0.56	0.18	0.4	0.32	0.51
Holocellulose content	-0.57	0.13	-0.49	0.61	-0.16
Lignin content	0.63	-0.15	0.41	-0.63	0.08
Eigen value (%)	3.73	2.52	1.73	1.63	1.18
Percent of variance	31.09	20.98	14.39	13.56	9.86
Cumulative percent	31.09	52.08	66.47	80.03	89.88

Table 6. Cluster analysis

Cluster	1	2	3
No. of mother trees in cluster count	5	8	6
Notation of trees	M_1, M_3, M_6, M_7,M_9	M_4, M_5,M_8, M_{10}, M_{11}, M_{14}, M_{16}, M_{17}	M_2, M_{12}, M_{13}, M_{15}, M_{18}, M_{19}
Bark percent	9.58	4.24	9.75
Wood percent	90.42	95.76	90.25
Moisture content	34.09	47.57	60.81
Maximum moisture content	68.17	95.14	121.62
Specific gravity	0.75	0.63	0.55
Fiber length	0.65	0.65	0.66
Fiber diameter	12.2	12.45	12.91
Cold water-soluble extractives	7.58	6.89	7.83
Hot water-soluble extractives	7.67	8.94	7.07
Alcohol- benzene soluble extractive	8.39	7.57	6.99
Holocellulose content	76.92	75.94	69.97
Lignin content	14.69	16.49	23.04

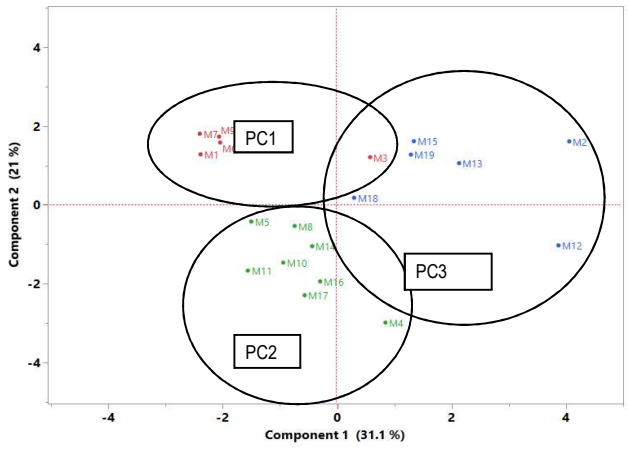

Fig. 1. Scatter plot diagram of PC1- PC2 for wood traits

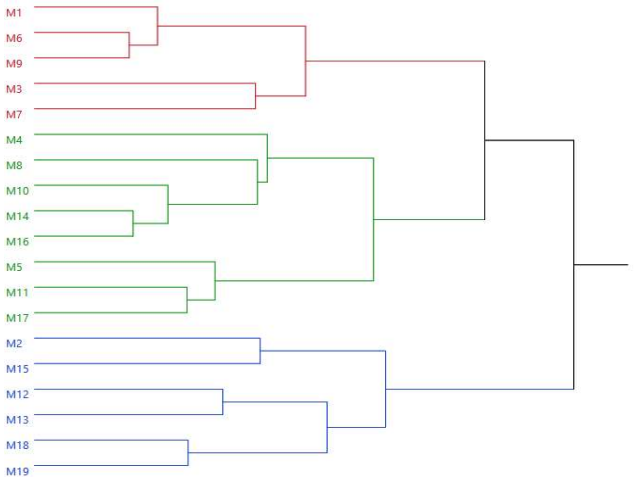

Fig. 2. Dendrogram showing clusters for wood traits

extractives. The highest amount of variance is justified by the first component and the remaining variances are justified by the subsequent components (Khadivi Khub and Khalili 2017).

Cluster I contained highest mean value for specific gravity (0.75), alcohol- benzene extractives (8.39) and holocellulose content (76.92). Cluster II contained maximum value for wood percent (95.76) and hot water solubility (8.94). Cluster III contained maximum values for moisture content (60.81), maximum moisture content (MMC) 121.62, fiber length (0.66) and fiber diameter 12.91 (Table 6).

CONCLUSION

Mother trees M_1 and $M_7$from Nalagarh have better strength properties (specific gravity) therefore, can be considered best with desirable timber qualities for furniture and musical instruments especially finger boards and keys of guitars and desks because of specific gravity. Mother trees with fiber parameters and holocellulose content can be used for paper and pulp making.

REFERENCES

Anonymous 1959a. *Water solubility of wood. Official standard*. T1m-59. Technical Association of Pulp and Paper Industry, New York, p22.

Anonymous 1959b. *Alcohol-benzene solubility of wood. Official standard*. T6m-59. Technical Association of Pulp and Paper Industry, New York, p 29-30.

Anonymous 1959c. *Lignin in wood. Official standard*. T12m-59. Technical Association of Pulp and Paper Industry, New York, p 36-37.

Anonymous 1959d. *Holocellulose of wood official standard*. T9m-59. Technical Association of Pulp and Paper Industry, New York, p 43-45.

BIS 1986. *Methods of testing of small clear specimen of timber*. Indian Standards Institution, New Delhi, p 62.

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Bisen GC and Gubre AP 2018. Evaluation of candidate plus trees of *Cleistanthus collinus* (Roxb.) for physico-chemical properties of wood. *International Journal of Pure and Applied Bioscience* **6**(5): 1134-1139.

Briggs D and Walters SM 1997. DNA: Towards an understanding of heredity and molecular evolution. In: *Plant Variation and Evolution*. 4th edition. Cambridge University Press, UK, p74-97.

Burton GW and De- Vane EW 1953. Estimating heritability in Tall Fescue (*Festuca arundineae*) from replicated clonal material. *Agronomy Journal* **4**: 78-81.

Desch HE and Dinwoodie JM 1996. *Timber Structure, Properties, Conversion and Use*. 7th edition, Macmillan press limited. London, p 360.

Falconer DS and Mackay TF 1996. *Introduction to quantitative genetics*.4th Edition, Addison Wesley Longman, Harlow.

Gamble JS 1972. A Manual of Indian. *Timbers* **26**: 333-339.

Gupta T and Sehgal RN 2000. Genetic variability in phenotypic characters of *Toona ciliate*. *Indian Journal of Forestry* **23**(4): 422-427.

Johnson HW, Robinson HF and Comstock RE 1955. Estimates of genetic and environmental variability in soybeans. *Agronomy Journal* **47**: 314-318.

Khadivi-Khub Aand Khalili Z 2017. A breeding project: The selection of promising apricot (*Prunus armeniaca* L.) genotypes with late blooming time and high fruit quality. *Scientia Horticulturae* **216**(14): 93-102.

Lush JC 1940. Interstice correlation and regression of offspring on damsana method of estimating heritability character. *In:Proceedings: Amercian Societyon Animal Production* **33**(1): 293-301.

Pandeya SC, Puri GS and Singh JS 1968. *Research Methods in Plant Ecology*. Bombay, Asia Publication House, p 286.

Sardeshpande M and Shackleton C 2019. Wild edible fruits: A systematic review of an under-researched multifunctional NTFP (non-timber forest product). *Forest* **10**(6): 467

Schneider EE 1916. Commercial Woods of the Philippines; Their Preparation and Uses. *Philippines Bureau of Forestry Bulletin No*. 14.

Smith DM 1954. Maximum moisture content method for determining specific gravity of small wood samples. US Forest Service. Forest Products Laboratory. Report No: 2014.

Ward JH 1963. Hierachical grouping to optimise an objective function. *Journal of the Amercian Statistical Association* **58**(301): 236-244.