CHEMICAL COMPOSITION AND WATER REPELLENCY PROPERTY OF TEN VILLAGE WOOD SPECIES

S. C. Das
S. Akhter
M. Sayeed

ABSTRACT

A study on chemical analysis and water repellency property of ten village wood species was conducted to find out the percentages of their chemical components. It was found that raintree *(Samanea saman)* possessed the highest amount of water soluble extractives. It was followed by babla *(Acacia nilotica* sub. *indica)*, mango *(mangifera indica)* and painya mandar *(Erythrina ovalifolia)*. Neem *(Azadirachta indica)* and jackfruit *(Artocarpus heterophyllus)* contained the least amount of this kind of extractives. Alcohol-benzene soluble extractives of the species fell in the range of 1.38-6.60%. The holocellulose content was the highest in tentul *(Tamarindus indica)*. Ghora neem *(Melia azadarach)* ranked the next in this respect. In consideration to the cellulose content, tentul, ghora neem, sissoo *(Dalbergia sissoo)*, mango and babla may be suitable for chemical pulping and conversion products.

These ten species were explored for water repellency test. Neem was found to absorb the least amount of water. In order of gradation on this aspect sissoo, babla and tentul were found to absorb slightly more water. These species may be suitable both for indoor and outdoor uses. Sorption of water in the remaining six species is considerably higher and consequently they are deemed not suitable for outdoor uses.

সারসংক্ষেপ

দশটি গ্রামীণ বৃক্ষ প্রজাতি কাঠের বিভিন্ন রাসায়নিক উপাদানের শতকরা হার নির্ণয়ের জন্য রাসায়নিক বিশ্লেষণ ও পানি রোধক গুণাগুণের উপর পরীক্ষা চালানো হয়। পানিতে দ্রবণীয় নির্যাসের পরিমাণ রেইনট্রি-তে সর্বোচ্চ এবং পরে অধঃক্রম অনুসারে আসে বাবলা, আম ও পাইন্যা মান্দার। নিম ও কাঁঠাল কাঠে তুলনামূলকভাবে উক্ত নির্যাসের পরিমাণ কম। এই সকল বৃক্ষ প্রজাতির কাঠে এ্যালকোহল বেনজিন দ্রবণীয় নির্যাসের পরিমাণ ১·৩৮–৬·৬০% এর মধ্যে রয়েছে। তেঁতুল কাঠে হলোসেলুলোজের পরিমাণ সর্বাধিক। অতঃপর আসে ঘোড়া নিম। কাঠে সেলুলোজের পরিমাণ বিবেচনায়, তেঁতুল, ঘোড়া নিম, শিশু এবং বাবলা কাঠকে মণ্ড ও রূপান্তরন দ্রব্য সামগ্রী তৈরীর কাজে অগ্রাধিকার দেয়া যেতে পারে।

এই দশটি কাঠের উপর পানি রোধক পরীক্ষা চালিয়ে দেখা যায়, নিম কাঠের পানি ধারণ ক্ষমতা সর্বনিম্ন। এই ক্ষেত্রে শিশু, বাবলা ও তেঁতুল, তুলনামূলকভাবে সামান্য বেশী পানি ধারণ করে। এগুলো ঘরের ভিতর ও বাইরে ব্যবহারের জন্য উপযোগী বলে বিবেচিত। অবশিষ্ট ছয়টি কাঠে পানি ধারণ ক্ষমতা খুব বেশী থাকায় ঘরের বাইরে ব্যবহারের জন্য উপযোগী বলে সুপারিশ করা যায় না।

S. C. Das, Junior Research Officer; S. Akhter, Junior Research Officer; M. Sayeed, Field Investigator, Bangladesh Forest Research Institute, P. O. Box 273, Chittagong, Bangladesh.

INTRODUCTION

The knowledge of the amount of chemical constituents of wood is a prerequisite in assessing the species for a particular end use. This is because the chemical constituents vary widely among different wood species (Sjostrom 1981). In Bangladesh there are about 150 wood species scattered all over the village groves. Many of these species are used for various purposes including as fuel. Uptil now there is no scientific study to characterise the species according to the end uses. With the lack of such knowledge many of the species are improperly used. Consequently, there is overexploitation of timber. This situation may be augmented if information of the amount of the chemical constituents and the absorption of water of the species is known. With these aims and views the study was conducted.

MATERIALS AND METHODS

The study was conducted with ten village wood species of Bangladesh. They were raintree *(Samanea saman)*, mandar *(Erythrina orientalis)*, neem *(Azadirachta indica)*, jackfruit *(Artocarpus heterophyllus)*, mango *(Mangifera indica)* painya mandar *(Erythrina ovalifolia)*, babla *(Acacia nilotica* sub. Sp. *indica)*, sissoo *(Dalbergia sissoo)*, ghora neem *(Melia azadarach)* and tentul *(Tamarindus indica)*. After the procurement, the species were identified by a wood anatomist. They were received in the disk form.

Chips were made from sapwood and heartwood taking approximately equal portions from both and were allowed to dry in a tray for 7 days in the laboratory. The wood chips were then fed in the laboratory Wiley Mill and powdered. The wood meal passing through the 40 mesh sieve and retained in 60 mesh sieve was collected. Extraneous matters and major components of wood were then determined according to TAPPI standards (1961) (T-1m-59, T-4m-59, T-6m-59, T-9m-54, T-203m-58).

Specimen samples of 0.6 cm thick in axial direction, 2 x 2 cm in radial-tangential direction were prepared taking equal portions from both heartwood and sapwood for determining the water repellency and dimensional stability. All the specimens were smoothened with a sand paper before putting them for drying in an oven for 48 hours at 105 ± 2°C. Eight specimens of the above dimensions were prepared, and four of them were subjected to alcohol-benzene extraction. Both extracted and unextracted specimen samples were then dried in an oven for 48 hours at 105 ± 2°C.

Both the extracted and unextracted specimens were cooled in a desiccator over calcium chloride. They were then soaked in distilled water in an air-conditioned room. The specimens were taken out of water at intervals of 1, 3, 5, 10, 15, 30, 45, 60, 90, 120 and 1440 minutes, the adhering water was blotted, weighed on an electric balance and measured the tangential dimensions with a set of slide callipers.

RESULTS AND DISCUSSION

Cold water, hot water, 1% caustic soda and alcohol-benzene solubilities of the meal of the wood species under study were determined. Percentages of holocellulose and alpha-cellulose were also determined. There were three replications in each experiment.

Cold water soluble extraneous matters were higher in painya mandar, raintree, babla and mango when compared to those of mandar, neem, jackfruit, sissoo, ghora neem and tentul (Table-1). Higher cold water soluble extraneous matters indicate the presence of higher percentages of tannins, gums, sugars, organic salts, cyclitons, galactons and pectine like materials in wood (Browning 1967). Again hot water soluble

extraneous matters were found higher in raintree, babla, painya mandar, mango and mandar than those of neem, jackfruit, sissoo, ghora neem and tentul. Higher hot water soluble extraneous matters indicate the presence of starch in addition to the cold water soluble extractives. When wood contains higher water soluble extractives, the presence of hygroscopic salt is indicated. Hygroscopic salt has the affinity to water as it forms hydrogen bonds when it comes in contact with water. Thus, the wood containing higher water soluble extractives tends to absorb greater amount of water. Due to this affinity of absorbing water, when the wood is used for outdoor purposes it comes in contact with the atmospheric moisture and rain water. This exposure of wood in the atmosphere causes to attract various wood destroying agents like fungus, termites etc. (Farmer 1967). Consequently due to attack of these wood destroying agents, the quality of the wood deteriorates and gradually the expected period of durability is lessened. Jackfruit, tentul, neem, ghora neem and sissoo were found to contain lesser amount of water soluble extractives. They are, therefore, considered suitable for both interior and exterior uses.

Babla, raintree and painya mandar were found to contain higher percentage of alcohol-benzene soluble extraneous matters compared to those of the rest seven wood species brought under investigation. Alcohol-benzene soluble extractives are waxes, fats, resins, terpenes etc. Alcohol-benzene soluble extractives in wood have no affinity toward water. So the wood, containing greater amount of alcohol-benzene soluble extractives does not absorb greater amount of water like the wood containing water soluble extractives. Alcohol-benzene soluble substances are toxic to some extent to the wood destroying agents. Due to the presence of higher percentage of such substances, the wood is not attacked by the above agents easily and the wood becomes durable. It is also known that wood having higher percentage of resinous matters has good polishing, varnishing and painting properties (Farmer 1967). Sissoo, raintree, painya mandar, ghora neem and jackfruit were found to have higher amount of alcohol-benzene soluble extractives. Due to the presence of higher amount of this extractive, the species are toxic to fungi and some other wood destroying agents. Such species may also possess good polishing, varnishing and painting properties.

On the contrary, the presence of higher amount of such extraneous matters creates problem during the process of chemical conversion products, viz., rayon, nylon, celluloid, pulp etc. Due to the presence of these extraneous and colouring matters, higher amount of chemical is consumed while making chemical conversion products. As a result the cost of products increases (Stewart and Watson 1962).

One percent caustic soda solubility percentage of babla was the highest whereas that of tentul was the least. Mango and ghora neem had almost the same caustic soda solubility, similarly it is marked that one percent caustic soda solubility was almost the same in the case of mandar and jackfruit. Higher caustic soda solubility indicates the presence of resinous matter and higher content of acetyl groups in the hemicelluloses (Razzaque 1986). It also focuses the degree of fungal decay in the wood. Higher the caustic soda solubility, lower will be the pulp yield. One percent caustic soda sloubility was found to be higher in babla, raintree, mango, ghora neem and sissoo. The amounts of resinous matter and acetyl group are higher in hemicelluloses of these species. These species are also susceptible to fungal decay.

Tentul was found to contain the highest amount of holocellulose. This species, and also ghora neem, sissoo, babla and mango contained an acceptable portion of holocellulose to produce chemical pulp. Raintree, neem, jackfruit, mandar and painya mandar were found to contain considerably lower percentage of holocellulose.

As such they are expected to produce low pulp yield.

Higher percentage of alpha-cellulose were found in ghora neem, sissoo, tentul, mango and painya mandar. Among these, tentul contained the highest percentage and the rest gradually came in order. In consideration to the higher percentage of cellulose content, the species like tentul, ghora neem, sissoo, babla and mango may be suitable for making rayon grade pulp.

It is observed from table 2 that the species like neem, tentul and jackfruit swell less. This is in conformity with less amount of water soluble extractives as found in Table 1.

Species like raintree, babla and sissoo are also more resistant on exposure to water. These species contained higher amount of water soluble extractives as noted in Table 1. These, therefore, ought to have swellen more. But practically they swelled less. This contradiction may possibly be due to the nature of the presence of water resistant extractives. However all these six species are water resistant and considered suitable for exterior uses. Mandar, painya mandar, ghora neem and mango with a high amount of water soluble extractives swelled rapidly. These wood species are considered unsuitable for exterior uses. These can be used for indoor uses.

CONCLUSION

From the study of chemical composition and water repellency property of ten village wood species, jackfruit, tentul, neem, ghora neem and sissoo having lesser amount of water soluble extractives are considered suitable for both indoor and outdoor uses.

Sissoo, raintree, painya mandar, ghora neem and jackfruit showing higher amount of alcohol-benzene soluble extractives are likely to possess good polishing, varnishing and painting properties.

Tentul, ghora neem, sissoo, babla and mango containing higher amount of holocellulose, may be suitable for chemical pulping. Presence of the higher amount of alpha-cellulose in ghora neem, sisoo, tentul, mango and painya mandar make them acceptable for making rayon grade pulp.

Neem, tentul, jackfruit, raintree, babla, sissoo are quite water resistant and as such these species are considered suitable for exterior uses. On the other hand mandar, painya mandar, ghora neem and mango donot possess water resistance property and swell considerably within a short span of time. Thus these species are not considered suitable for exterior uses. However, they can find uses for indoor purposes.

Table 1. Chemical composition and extractives of ten village wood species

Name of Species	Cold water solubility (%)	Hot water solubility (%)	1% caustic soda solubility (%)	Alcohol-benzene solubility (%)	Holocellulose (%)	Alpha-cellulose (%)
Neem *(Azadirachta indica)*	4.75	5.98	16.7	3.58	67.2	39.7
Jackfruit *(Artocarpus heterophyllus)*	4.00	5.25	18.5	5.20	68.0	37.8
Raintree *(Samanea saman)*	8.89	10.3	23.2	6.30	67.2	36.0
Mandar *(Erythrina orientalis)*	6.01	9.00	18.4	3.14	68.1	37.0
Babla *(Acacia nilotica* Sub. sp. *indica)*	7.73	10.2	24.9	3.43	72.3	39.3
Painya mandar *(Erythrina fusca)*	8.99	9.70	16.9	6.15	69.2	41.5
Mango *(Mangifera indica)*	7.20	9.48	20.6	4.06	70.9	42.8
Sissoo *(Dalbergia sissoo)*	6.00	7.08	19.8	6.60	72.8	45.8
Ghora neem *(Melia azadarach)*	4.96	6.69	20.0	5.22	76.1	46.9
Tentul *(Tamarindus indica)*	4.34	5.45	15.7	1.38	78.0	42.9

Table 2. Water repellency property of 10 village wood species.

Name of species	Treatment	Change in tangential dimension (%) with period of soaking			Change of water sorption (%) with period of soaking		
		1 hr	2 hrs	24 hrs	1 hr	2 hrs	24 hrs
Neem (*Azadirachta indica*)	Unextracted	0.52	1.04	2.08	10.7	13.9	39.8
	Extracted	0.52	0.52	1.55	25.9	29.9	34.6
Jackfruit (*Artocarpus heterophyllus*)	Unextracted	0.54	1.63	2.17	28.4	35.5	72.3
	Extracted	0.82	1.36	3.00	25.9	29.9	50.0
Raintree (*Samanea saman*)	Unextracted	0.98	0.98	0.98	17.6	23.8	66.3
	Extracted	0.49	0.49	0.49	12.1	17.2	60.6
Mandar (*Erythrina orientalis*)	Unextracted	1.82	1.82	2.73	97.2	132	263
	Extracted	0.90	1.35	1.80	62.8	84.6	217
Babla (*Acacia nilotica* Sub. sp. *indica*)	Unextracted	0.94	1.41	1.41	10.6	13.8	47.5
	Extracted	1.98	2.97	3.96	11.5	15.2	54.4
Painya mandar (*Erythrina fusca*)	Unextracted	2.84	3.32	3.79	143	161	239
	Extracted	2.43	2.43	2.91	124	157	263
Mango (*Mangifera indica*)	Unextracted	1.97	2.46	2.46	42.9	52.8	99.4
	Extracted	2.51	3.01	3.52	55.7	72.5	132
Sissoo (*Dalbergia sissoo*)	Unextracted	1.53	2.55	4.59	11.6	14.9	39.3
	Extracted	2.56	3.07	3.59	16.1	21.8	47.9
Ghora neem (*Melia azadarach*)	Unextracted	4.57	5.58	6.59	44.1	15.9	112
	Extracted	9.35	9.94	15.8	49.9	62.7	125
Tentul (*Tamarindus indica*)	Unextracted	3.98	5.47	6.96	21.7	27.0	46.3
	Extracted	5.97	7.46	7.46	38.5	42.0	54.7

REFERENCES

Browning, B. L. 1967. Methods of wood chemistry, Vol-I, Institute of paper chemistry, Appleton, Wisconsin. pp : 79-82

Dadswell, H. E. and Stewart, C. M. 1962. Chemical Utilization of the Eucalypts, In : Chemical Utilization of the Eucalypts. I-II, Division of Forest Products Technological Paper No. 17, Commonwealth Scientific and Industrial Research Organization, Australia. pp 1-17

Farmer, R. H. 1967. Chemistry in the Utilization of Wood. Forest Products Research Laboratory, Princes Risborough, England. pp 1-141

Razzaque, M. A., Das, S. C., Shaheen Akhter and Sayeed, M., 1986. Economic and chemurgic prospects of *Cajanus cajan*. Bano Biggyan Patrika 15 (1 & 2) : 16-20

Sjostrom Eero 1981. Wood Chemistry, Fundamentals and Applications. Helsinki University of Technology, Espoo, Finland. P : 87

Stewart. C. M. and Watson, A. J. 1962. Chemical Utilization of the Eucalypts. In : Chemical Utilization of the Eucalypts. I-II, Division of the Forest Products Technological Paper No. 17 Commonwealth Scientific and Industrial Research Organization, Australia. pp 18-39

TAPPI Standard, 1961. 360 Lexington Avenue, New York- 17, New York