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Comparison between Different Components of Some Available Hardwood and Softwood in Bangladesh

NowshinFarjana Silvy[1],Md. Shamim Reza[2],Md. Nazim Uddin[3,]* and Meghla Akther[4]

[1]*Department of Chemistry, Military Collegiate School Khulna (MCSK), Bangladesh.*
[2]*Department of Chemistry, North Western University, Khulna, Bangladesh.*
[3,4]*Department of Chemistry, Khulna University of Engineering and Technology, Khulna, Bangladesh.*

Abstract: *This research was conducted to examine comparison between hardwood and softwood components. Cellulose, hemicellulose and lignin are major constituents for both hardwood and softwood. Depending on these constituents wood's application varies. In this study we examined 10 important wood samples (5 are hardwoods & 5 are softwoods) which are mostly available in Bangladesh. The wood samples were tested in some standard chemical methods, whose samples were dewaxed and depectinised, then the lignin content was measured (mainly using H_2SO_4). After the removal of the lignin, two other mains components α-cellulose and hemicelluloses were measured. The average components values are 40-50% cellulose, 15-40% hemicelluloses and 18-25% lignin for hardwoods. On the other hand, the average components values are 40-45% cellulose, 24-37% hemicellulose and 25-30% lignin for softwoods.According to their lingo-cellulosic contents they can convert into various useful products. Also by these constituents of hardwood and softwood they may be useful for same or different purposes.*

Keywords: *Softwood, Hardwood, Cellulose, Hemicellulose and Lignin.*

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I. Introduction

Wood, as the traditional resources, is used in many ways to support our life, e.g.energy, building, paper and chemicals etc. With the hot topics in our societyconsidering energy crisis, environment issue and sustainable development, the biochemical refined from wood become especially important field for the research andindustry development all over the world [1].

According to natural durability of timber woods are generally classified in two groups: softwood and hardwood. Softwood is generally white in color, non-durable, light and sustainable to insect and fungus. Hardwood is generally strong, heavy, non-durable and resistant to fungus and insects.Cellulose, hemicelluloses and lignin are major constituents of any type of wood both for hardwood or softwood.These compounds are also major components of natural lingo-cellulosic materials. Cellulose molecules arranged regularly, gather into bundles, and determine the framework of the cell wall. Fibers are also filled with hemicellulose and lignin. The structure of the plant cell wall is compact. There is different bonding among cellulose, hemicellulose, and lignin. Cellulose and hemicellulose or lignin molecules are mainly coupled by a hydrogen bond [2, 3].

Cell walls mainly consist of cellulose, hemicellulose, and lignin in a 4:3:3 ratios. This ratio differs from sources such as hardwood, softwood, and herbs. Besides these three components, natural lingo-cellulosic materials contain a small amount of pectin, nitrogenous compounds, and the secret ash. Depending on these constituents wood's application varies[4].So, it is very much important to measure wood's constituents. But there are very little information regarding chemical component of different hardwood and softwood of major tree species in Bangladesh. This study are undertaken to find out the chemical component and differences between hardwood and softwood of some major tree species in Bangladesh.

II. Materials and Methods

Wood samples:

In this study 10 wood samples (5 hard wood samples and 5 soft wood samples) were collected from different sites in Bangladesh.The ten normal trees were randomly selected to determine different components. Theselected wood samples name isgiven in Table 1.

Table-1: Name ofselected Hardwood and softwood samples.

SL. No.	Hardwood species	Softwood species
1.	Babla (*Acacia nilotica*)	Bot (*Ficusbengalensin*)
2.	Shilkoroi (*Albiziaprocera*)	Shimul (*Bombaxceiba*)
3.	Mahogony (*Swieteniamahogoni*)	Krishnochura (*Delonixregia*)
4.	Rain tree (*Salmaniasaman*)	Kodom (*Anthocephaluschinensis*)
5.	Akashmoni (*Acacia auricaliformis*)	Ipilipil (*Leucaenaleucocephala*)

Experimental Procedure:

Estimation of Lignin: Dewaxed and depectic fibre dried at 105 °C for 0.5hr then it is treated with 72% Sulphuric acid.Taking 15ml acid for 1 gmfibre with frequently stirring at ordinary temperature. The mixture is allowed; to stand for 2 hours and then diluted to 3% acid concentration.After refluxing the mixture for 4 hours it is allowed to standfor overnight and filtered through a sintered glass funnel and washed thoroughly with hot distilled water. The constant weight of the residue in the sintered funneldried at 105 °C (gives the amount of the lignin content of the fibre.

Let, Weight of dewaxed and depecticfibre = W gm

Weight of filter paper = W_1gm

Weight of filter paper + Lignin =W_2gm (after filtration)

There for, Weight of Lignin = $(W_2-W_1)=W_3$ gm (Suppose)

% of Lignin = $W_3/W * 100$

Estimation of α-cellulose and hemicellulose:

In this step all non-cellulosic matters of the fibre are removed by the treatment of the bleaching agentsuch as Sodium chlorite where chlorite holocellulose, a combination of a-cellulose and hemicellulose is obtained.

Preparation of Chlorite holo-celluloce:

A suitable amount of dewaxed and dcpectinisedfibre dried at 105 °c is treated with 0.7% Sodium Chlorite solution by adding 80ml liquor for 1 gmfibre. Then the solution is buffered at pH= 4 by adding 1 ml buffer solution (CH_3COOH+ CH_3COONa) for every 10ml of Chlorite solution taken. Finally, the solution is heated at $(90\text{-}95)^0$cfor 90 minutes. After heating,the fibre is filtered, washed thoroughly with distilled water and then treated with 0.2% Sodium meta-bisulphite solution in a fibre liquor ratio of 1:20 for 15minutes.The cellulosic materials obtained on the filter paper is called Chlorite-holocellulose which is dried at 105^0Cuntil constant weight is obtained.

Separation of α-Cellulose from Hemicellulose:

The dried Chlorite-holocellulose is treated with 24% KOH solution at ordinary temperature for 4 hours with occasional stirring. In this case 100ml KOH solution is taken for 1 gmfibre. By this treatment hemicellulose is dissolved in solution and **α**-Cellulose remains undissolved. The **α**-Cellulose is separated by filtration, washed thoroughly with 2% Acetic Acid solution, finally with distilled water and then dried at 105^0C until constant weight is obtained. The amount of **α**-Cellulose thus obtained is deducted from the weight of holocellulose taken gives the amount of hemicellulose.

Let, Weight ofdewaxed&depectinised saw dust = W gm

Weight of filter paper = W_1gm

Weight of filter paper + chlorite holocellulose = W_2gm

Therefore,Weight of chlorite holocellulose = $(W_2-W_1) = W_3$

Again, Weight of filter paper + α-Cellulose = W_4gm (after KOH treatment)

Therefore, Weight of α- Cellulose = $W_4-W_1=W_5$

Weight of hemicellulose = $W_3-W_5=W_6$

% of α-cellulose = $W_5/W*$ X 100

% of hemicellulose = $W_6/W*$ X 100.

III. Results and Discussion

The measured components (Cellulose, Hemicellulose and Lignin) in percentages of the selected wood samples and basic comparison between hard wood and softwood are presented in Table-2 and Table-3. Also the SME image and chemical compositionof Hardwood and Softwood are shown in Figure-1, Figure-2 and Figure-3 respectively.

Table-2: Comparison between the components of hardwood and softwood samples

Species	Woods	Cellulose%	Hemicellulose%	Lignin%
Hardwood	Babla(*Acacianilotica*)	43.90	17.70	18.36
	Shilkoroi(*Albiziaprocera*)	40.20	22.09	29.10
	Raintree(*Samniasaman*)	49.03	27.08	21.10
	Mahogoni(*Swieteniamohogoni)*	57.90	11.20	28.50
	Akashmoni (*Acacia auriculiformis*)	67.65	20.59	7.10
Softwood	Ipilipil(*Leucaenaleucocephala)*	51.70	14.00	18.40
	Bot(*Ficusbengalensis*)	33.19	40.67	25.09
	Shimul (*Bomboxceiba*)	45.00	19.20	24.50
	Krishnochura(*Delonixregia*)	67.60	10.87	8.13
	Kodom(*Anthocephaluschinensis*)	40.00	34.90	6.03

Table-3: Basic comparison between hardwood and softwood

Improve chart	**Hardwood**	**Softwood**
Cost:	Hardwood is typically more expensive than softwood.	Softwood is typically less expensive compared to hardwood.
Density:	Hardwood has a higher density and is therefore harder	Softwood has a lower density, therefore most softwood varieties are softer than hardwood.
Found in regions:	Trees supplying hardwood are found throughout the world from the Boreal and Taiga forests of the North to the tropics and down into the far South.	Found in the northern hemisphere.
Examples:	Examples of hardwood are mahogany, teak, walnut, oak, ash, elm, aspen, poplar, birch, maple etc.	Examples of softwood trees are pine, spruce, cedar, fir, larch, douglas-fir etc.
Growth:	Hardwood has a slower growth rate.	Softwood has a faster rate of growth.
Type:	Mostly deciduous. Some European evergreen trees that yield hardwood are holly, boxwood and holm oak.	Evergreen.
Properties:	Broad leaves; enclosed nuts; higher density: not all hardwood is hard e.g. poplar and basswood.	Less dense; less durable; high calorific values;coniferous trees.
Shedding of leaves:	Hardwoods shed their leaves over a period of time	Softwoods tend to keep their leaves throughout the year.
Definition:	Comes from deciduous trees that drop their leaves every year.	Trees that are conifer and have needles, and normally do not lose needles.
Applications:	Used for trimmings and furniture but less frequently than softwood.	Widely used as woodware for building (homes/cabins) and furniture.

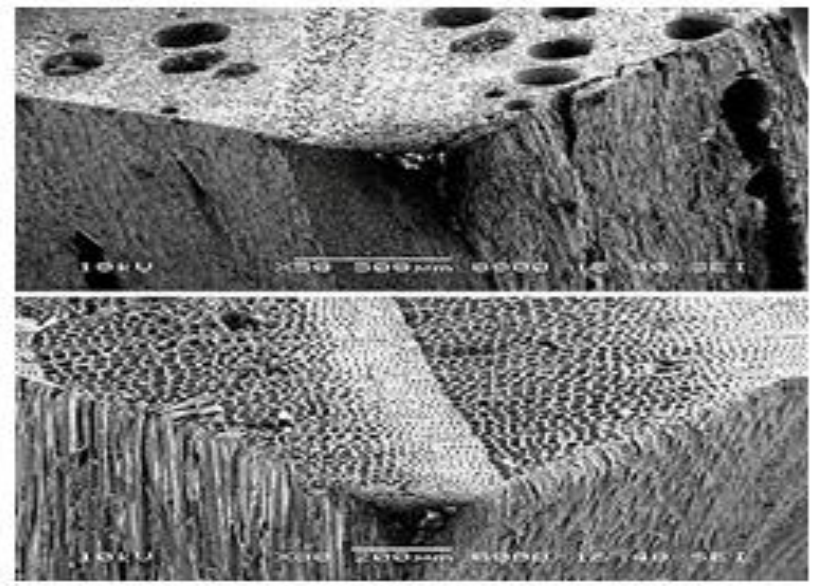

Figure-1: SEM images showing the presence of pores in hardwoods.

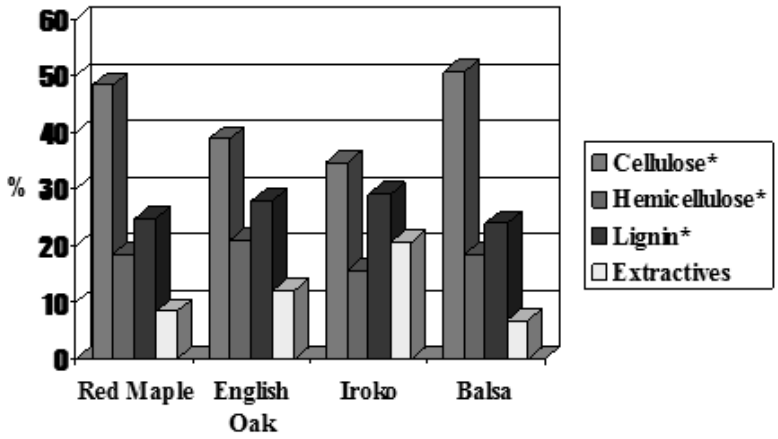

Figure-2: Chemical composition of Cellulose, Hemicellulose and Lignin in hardwood on extractive free wood basis.

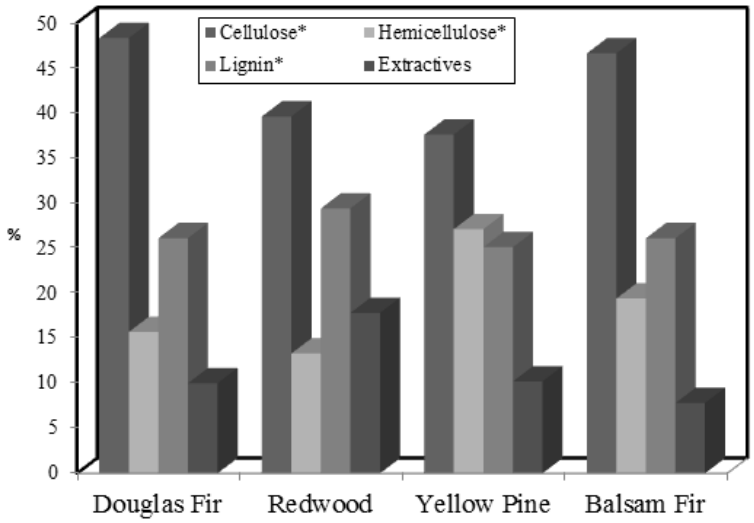

Figure-3: Chemical composition of Cellulose, Hemicellulose and Lignin in softwood on extractive free wood basis.

SEM images have shown that Hardwoods have a more complex structure than softwoods (Figure-1). The dominant feature separating "hardwoods" from softwoods is the presence of pores, or vessels [5]. The vessels may show considerable variation in size, shape of perforation plates (simple, scalariform, reticulate and foraminate) and structure of cell wall, such as spiral thickenings. The basic comparison between Hardwood and Softwood are shown in Table-3.

Experimental results show that the cellulose contents in hardwood species is average but in softwood species differs widely from one to another (Table-2 and Table-3). This cellulose is the major constituent of paper, paperboard and card stock and of textiles made from cotton, linen and other plant fibers [6]. Similarly Hemicellulose contents in hardwood species is average but in rain tree the content is quite more but in softwood species the content is large for the sample Bot and Kodom quite large, for another three samples the contents are quite small. More % of Hemicellulose both in softwoods & hardwoods is useful as animal food. On the other hand Lignin contents for hardwood species mostly above 20.00 (Only exception for Akashmoni lignin content is only 7.10), but in softwoods lignin contents are mostly small; but for Bot and Shimul the contents are quite large (>20.00). Highly lignified wood is durable and therefore a good raw material for many applications [7]. It is also an excellent fuel, since lignin yields more energy when burned than cellulose. From the above study it isseen that each of the wood has different components in different ratio. So there are different applications of different types of wood.

IV. Conclusion

From the above study, it can be concluded that cellulose, hemicelluloses and lignin are the main components of hardwood and softwood. Percentages of the components (Cellulose, hemicellulose and lignin) vary in different hardwood and softwood.The application of wood depends on the percentage of these components. So, it is very important to know the presence of different components in various hardwood and softwood but limited published data are available on components present of hardwood and softwood in Bangladesh.However, the findings of the present study would be helpful as baseline information for further study in future.

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