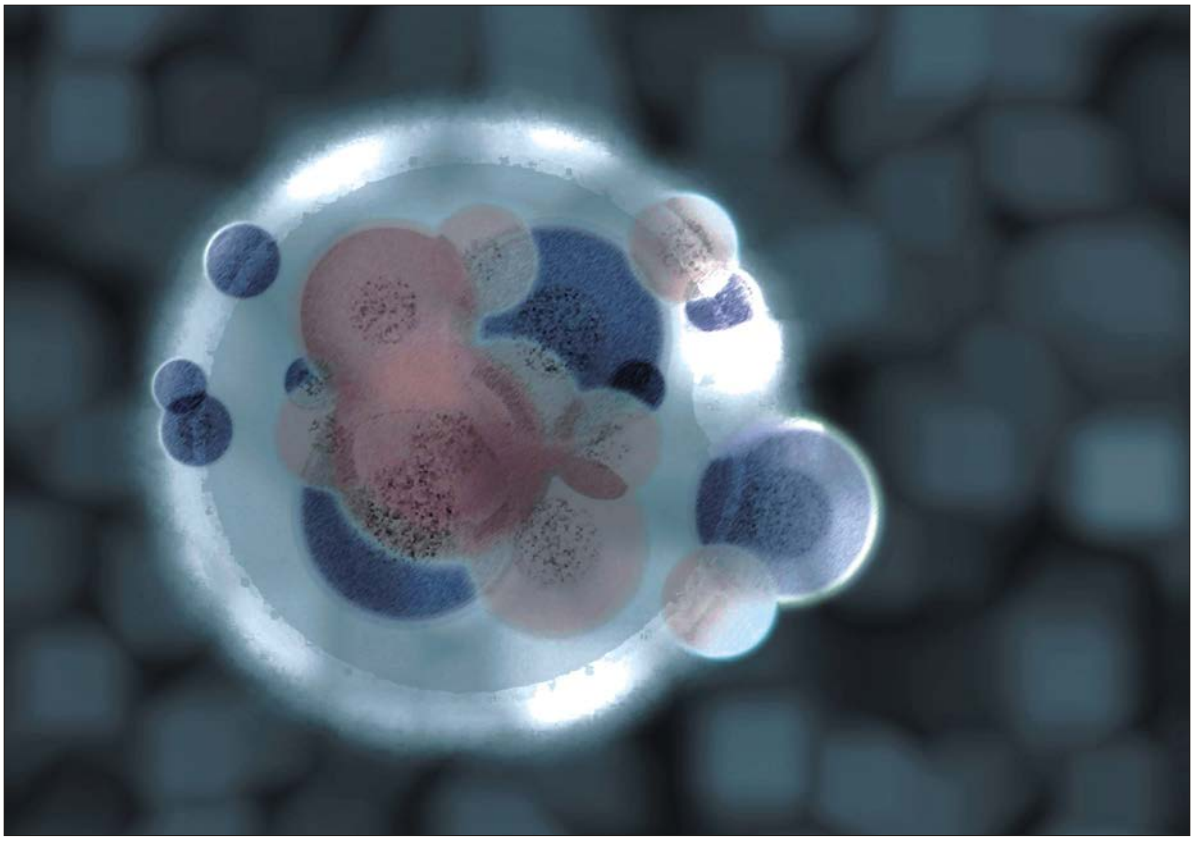

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Manufacture and Properties of Particleboard from Dhaincha (*Sesbania aculeata*)

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Abstract: A study was conducted to evaluate the feasibility of using dhaincha (*Sesbania aculeata*) for particleboard manufacturing. The physical and mechanical properties of dhaincha particleboard were examined to assess its quality. It was found that the density of dhaincha particleboard was 602 kg m^{-3}, the modulus of rupture was 154 kg cm^{-2}, the modulus of elasticity was 21649 kg cm^{-2}, the tensile strength was 9.3 kg cm^{-2}, screw withdrawal capacity was 81 kg in edge and 82 kg in face, the surface soundness was 16 kg cm^{-2}, the percentage swelling in thickness were 1.8 after 2 h and 9.5 after 24 h, the percentage swelling in width were 0.42 after 2 h and 0.67 after 24 h, the percentage of swelling in length were 0.35 after 2 h and 0.66 after 24 h, the absorption of water were 26.8 after 2 h and 69.49% after 24 h, the moisture content after curing was 6.5% for dhaincha particleboard. Therefore, dhaincha can be an alternative raw material for the particleboard industries.

Key words: Dhaincha, *Sesbania aculeate,* particleboard

INTRODUCTION

Wood is one of the earth's most valuable resources and it conforms to the most varied requirements. About 70% demand for timber and 90% for fuel wood of the country is met from the trees grown in the village groves of Bangladesh (Anonymous, 1987). There are about 150 tree species grown in the homestead and village groves of Bangladesh (Das, 1990). Only a few of them are being used by the plywood, tea chest and particleboard industries. About 16 timber species are recommended for decorative veneer and decorative plywood (Anonymous, 1986), 17 for marine plywood (Anonymous, 1985a), 46 for manufacture of ply for general purposes (Anonymous, 1983), 36 for plywood and battens for tea chest (Anonymous, 1979) and 5 selected species, viz., civit (*Swintonia floribunda*), garjan (*Dipterocarpus* sp.), chapalish (*Artocarpus chaplasha*), narikeli (*Pterygota alata*) and pitali (*Trewia nudiflora*) are recommended for particleboard manufacturing plant of Bangladesh Forest Industries Development Cooperation (Anonymous, 1981). These timber species make the total of 120 which practically from only 55 timber species out of 500 hardwood timber species available in the forest of Bangladesh (Anonymous, 1984). In addition, kadam (*Anthocephalus chinensis*), chatian (*Alstonia scholaris*), jute stick, etc are used in the private particleboard industries in Bangladesh. These species are now in short supply because of their extensive extraction. To reduce pressure on these species and to fulfill the demand of the particleboard industries it is essential to introduce an alternative species for manufacturing particleboard.

Dhaincha (*Sesbania aculeata*) is a green manure crop useful in paddy cultivation and is one the most valuable medicinal herb. It is a lingo-cellulosic material, which reduces soil erosion and increase soil fertility having multipurpose uses and fast growing characteristics (Pankaj, 2003). Presently, it is grown in most of the areas of Bangladesh because of its least maintenance and tending operation cost and is used only as a fuel wood. But it can also be used as an alternative raw material to produce particleboard. It will ensure its optimum utilization as well as the particleboard industries will find out an alternative raw material for their industries. Therefore, particleboard was manufactured from dhaincha and its properties was analyzed.

MATERIALS AND METHODS

Collection of raw materials: Dhaincha was collected from Mamikgong, Bangladesh. The particleboard was manufactured in Akij Particleboard Mills Ltd. which is one of the biggest particleboard industries in Bangladesh. Particleboard was made into the industry to find out the quality of dhaincha as an alternate raw material in mill scale after a long trial in the laboratory scale.

Manufacturing conditions: Chipping was done at the chipper except the root and leaves. Flaking was done in to the flaker machine. After flaking, the chips were then dried at 110°C. The moisture content of the dried chips

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Table 1: Components of adhesive with its percentage for core and fine chips

Components of adhesive	Core chips	Fine chips
Urea formaldehyde	58% of adhesives	58% of adhesives
Water	41.2% of adhesives	41.2% of adhesives
Wax emulsion	0.8% adhesives	0.8% adhesives
Hardener (23% Ammonium chloride)	105 g/ board	60 g/ board

was 3.8% and bulk density was 164.8 kg m^{-3}. Dried chips were screened in a sieve (# 16) to separate the core and fine chips. The moisture content of the core and fine chips were increased up to 7.8 and 8%, respectively. Blending was done in to a blender with adhesives (Table 1) where the moisture content of core and fine chips were 14.2 and 17.1%, respectively. The amount of adhesives was 15% of the chips on weight basis.

In the mat, the percentage of the thickness of top, core and bottom layer were 22, 58 and 20%, respectively. The average thickness and weight of the mat was 42 mm and 35.5 kg/board, respectively for the board size of 3.66 m×1.22 m×12 mm. After mat formation, the mats were sent to the hot press for 8 min and 18.5 sec at 165°C temperature and 20 MPa pressure. The board was cooled and conditioned after hot pressing and then trimming was done to get the desired size.

Particleboard properties analysis: Samples were collected from the board and were analyzed by IMAL (IB 600) machine. Samples were taken according to the IMAL (IB 600) standard. All the properties of the particleboard were analyzed according to the machine standard.

RESULTS AND DISCUSSION

Density and density distribution: It was found that the density of dhaincha particleboards was 602 kg m^{-3} (Table 2). According to IS specification 3087 (Anonymous, 1985) the density of standard particleboard is 500-900 kg m^{-3} and according to German Standard Din 68761 (Verkor, 1975), particleboard standard is 600-750 kg m^{-3}. Therefore, the particleboard made from dhaincha follows both the standard.

Static bending strength: It was found that MOR for dhaincha particleboard was 154 kg cm^{-2} (Table 2). MOR of a standard particleboard is 112, 180 and 140.72 kg cm^{-2} according to IS specification 3087 (Anonymous, 1985), German Standard Din 68761 (Verkor, 1975) and BS speciation 5669 (Anonymous, 1975), respectively. The MOE for dhaincha particleboard was 21649 kg cm^{-2} which also followed the standard.

Tensile strength: The tensile strength of dhaincha particleboard was 9.3 kg cm^{-2} (Table 2). For a standard particleboard, it is 8, 3.5 and 3.47 kg cm^{-2} according to IS specification 3087 (Anonymous, 1985), German standard Din 68761 (Verkor, 1975) and BS speciation 5669 (Anonymous, 1975), respectively. So, it has higher tensile strength than any standard particleboard reflecting its good quality.

Table 2: Properties of particleboard made from dhaincha

Name of properties	Average
Density and density distribution (kg m^{-3})	602.00±15
Static bending strength (kg cm^{-2})	
Modulus of Rupture (MOR)	154.00±7
Modulus of Elasticity (MOE)	21649.00±245
Tensile strength (kg cm^{-2})	9.30±2.1
Screw withdrawal capacity (Kg)	
Face	82.00±5.2
Edge	81.00±6.4
Surface soundness (kg cm^{-2})	16.00±0.8
Swelling (%)	
At length after 2 h	0.35±0.08
At length after 24 h	0.66±0.10
At width after 2 h	0.42±0.08
At width after 24 h	0.67±0.12
At thickness after 2 h	1.80±0.26
At thickness after 24 h	9.50±0.36
Water absorption (%)	
After 2 h	26.80±0.52
After 24 h	69.49±0.86
Moisture content after curing (%)	6.50±0.27

Screw withdrawal capacity and surface soundness: Screw withdrawal capacity was found 81 kg in edge and 82 kg in face for dhaincha particleboard. It has also followed the standard. It was found that the surface soundness for dhaincha was 16 kg cm^{-2} (Table 2).

Swelling: It was found that after two h, thickness swelling percentage in thickness of dhaincha particleboard was 1.8 (Table 2). According to IS specification 3087 (Anonymous, 1985), German standard Din 68761 (Verkor 1975) and BS speciation 5669 (Anonymous, 1975) it is 10, 6 and 12, respectively after two h except BS specification where it is for one h. After 24 h, thickness swelling percentage was 9.5 in dhaincha particleboard. Swelling in width was 0.42 and 0.67 after 2 and 24 h, respectively for dhaincha particleboard. In longitudinal direction, it was 0.35 and 0.66 after 2 and 24 h, respectively.

Water absorption: It was found that absorption of water by dhaincha particleboard was 26.8 and 69.49% for 2 and 24 h, respectively (Table 2). According to IS specification 3087 (Anonymous, 1985) the absorption of water by a standard particleboard is 25 and 50% after 2 and 24 h, respectively. After 2 h, dhaincha particleboard absorbs slightly higher water than the standard one but after 24 h it absorbs quite higher amount of water.

Moisture content after curing: After curing, the moisture content was 6.5% for dhaincha particleboard which is very good in use (Table 2).

From the above properties analysis, it has been found that particleboard made from dhaincha confirms its good quality. It has very high tensile strength and less swelling as well as good surface soundness and screw holding capacity. It has some affinity to water but this can be minimized by adding water repellent chemicals. Considering all the above factors it can be concluded that dhaincha can be an alternative raw materials for the particleboard industries. It will save important forest resources as well as money.

CONCLUSIONS

The standard of dhaincha particleboard was assessed by examining the physical and mechanical properties. Particleboard from dhaincha is of international standard. The present condition of particleboard industries is that, they are suffering from scarcity of raw materials. It is necessary to introduce an alternate raw material to reduce pressure on existing raw materials as well as on the forest resources. If dhaincha is used commercially for manufacturing particleboard, it will be an appropriate alternate source of raw material for particleboard industries. At the same time, dhaincha will achieve an important economic value. In this situation, the government and particleboard industry owners should take initiatives to utilize dhaincha for the commercial production of particleboard.

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