

Date-palm leaf particle boards – a wood substitute for various applications

S.K. Ghosh* and L.K. Nayak

National Institute of Research on Jute & Allied Fibre Technology (ICAR), 12, Regent Park, KOLKATA (W. B.) INDIA

ABSTRACT

Particle – Boards have been successfully developed from Date – palm leaves, the agro-waste,¹ in the laboratory scale as well as successful pilot plant trial had been conducted in a reputed Board making factory of West Bengal. The Physico- mechanical properties of Date- Palm leaf Particle- Board have been measured and showed very encouraging result. A successful application of Date – Palm leaf (DPL) had been translated for fitting false ceiling of Room No – 1 of NIRJAFT Trainees' hostel in the Month of May. The cost of the DPL Particle Board is about 20% of the cost of the plywood/wood material.

Key words : DPL, Particle – Boards, Properties, Optimization, Utilisation

INTRODUCTION

No research work has ever been done to develop the particle Board from DPL in India and abroad². In the world, Iraq has been producing thermal insulating Boards for covering electrical wires. In India, NIRJAFT (I.C.A.R.), 12, Regent Park, Kolkata – 40 only has done successful research work in the laboratory scale to produce the DPL Boards and its application for the false ceiling.

Wood resources are continuously depleting while the demand is increasing day by day with the growth income, population in general and increased activity in the construction sector with a view to conserve the forest resource and consequently shortage of wood, the existing wood, plywood, fibre board can't meet the increasing demand³. Currently present requirement of wood is 31 million cubic meters whereas,

the estimated production is only 16 million cubic meters (FAO Report). In this back- drop, low cost particle Boards from DPL, the annually renewable agro-wastes, may be developed as the substitute of the costly wood product.

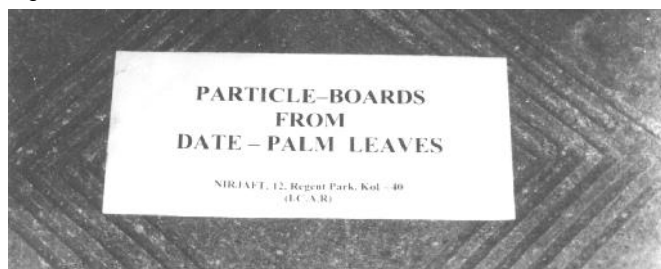
REVIEW OF LITERATURE

India is bestowed with huge agricultural wastes and value added items like particle- Board may be developed at low cost but no research work has ever been done to develop particle board from Date- Palm leaves , the agro-waste. In Abroad, North Africa has been using DPL for making huts. Mature leaves are made into mats, screens, baskets, crates and fans. The processed leaflets, combined with ground up peanuts shells and corn cobs are used for making insulating boards. The leaf petioles have been found to be the good source of cellulose pulp. It has been tested as material for filtering drainage pipes in Iraq, as a substitute for imported filters.

MATERIALS AND METHODS

Matured Date palm leaves (60 days' of age) were air dried for 7 days. The dried leaves were cut to small pieces ($1/2^2$ to 1^2) and then chipped /ground in a grinding machine. The chipped DPL particles

Fig. 1 :



*Author for correspondence

(40 mesh) after uniform mixture with synthetic resins (Urea – Formaldehyde & Phenol – Formaldehyde) and natural resin (Tamarind seed powder) were taken separately in a metallic frame ($6^2 \text{ C } 6^2$) and were pressed in a hydraulic machine under specific temperature (160°C), pressure ($20\text{Kg}/\text{cm}^2$) and time of 20 minute. Nine types of DPL Particle- Boards using three varieties of resin of different concentrations (10 %, 15% & 20%) were developed keeping all the parameters (time, temperature and pressure) unaltered. The relevant physical and mechanical properties Viz. moisture content (%), Density (gm / cm^3), water absorption (%), Bulk swelling (%), Thickness swelling (%), Tensile strength (N/ mm^2), Flexural modulus (Mpa), Impact strength (Kg.m) etc. were determined to assess the suitability of DPL Boards as a substitute of costly wood products. Tensile strength and Flexural strength of DPL Boards were measured in Instron Tensile strength Tester (No. 5567, 30 KN max Load) and impact strength of boards were measured in Avery Impact Testing M/C. The photographs of DPL Particle Board (fig. 1) and application for false ceiling (fig. 2) have been presented.

Fig. 2 :



RESULTS AND DISCUSSION

Date palm leaf (DPL) is more or less similar to wood in chemical composition (Table – 1)⁴. So it may be used as a replacement of wood depending upon the end uses. Various characteristics of DPL Particle – Boards using different concentrations of resins (U.F., P.F. and T.S.P.) are given in Table – 2 and Table – 3. The results of Table – 2 indicates that as the resin concentration increases, the tensile strength, Flexural modulus and Impact strength increases. From Table – 3, it appears that water absorption (%), Bulk swelling (%) and Thickness swelling (%) in water increased from 1 hr to 24 hrs soaking time but with the gradual increase of the concentration of the resins, the reverse trend (Decreasing) was observed. Boards

Table 1 : Composition of different Raw Materials (%)

Constituents	Date – Palm Leaves(DPL)	Jute – Stick ⁴	Biogases	Hard Wood	Soft - Wood
α - Cellulose	58.0	40.8	54.5	40.43	40.43
Hemicelluloses	20.0	31.9	24.5	30.35	25.30
Lignin	15.3	23.5	20.0	20.25	25.30
Ash	1.75	0.70	1.17	-	-
Others	3.0	3.00	0.33	-	-

Table 2 : Mechanical Characteristics of Date – Palm Leaf Boards

Resin	% of Resin	Tensile Strength (N / mm ²)	Flexural Modulus (Mpa)	Impact Strength Kgm.
UF	10	0.41	21.01	0.070
	15	0.45	71.55	0.081
	20	0.52	97.73	0.083
PF	10	0.62	58.48	0.850
	15	0.71	79.78	0.910
	20	0.85	110.68	0.110
TSP	10	0.35	10.52	0.064
	15	0.47	14.61	0.070
	20	0.45	20.60	0.081

Table 3 : Physical Characteristics of Date – Palm Leaf Boards

Resin	% of Resin	Moisture Content (%)	Density (gm /cm ³)	Water Absorption (%)			Bulk Swelling (%)			Thickness Swelling (%)		
				1hr	2hrs	24hrs	1hr	2hrs	24hrs	1hr	2hrs	24hr
U.F.	10	11.01	0.41	33.69	50.12	82.50	6.15	8.46	15.38	5.20	7.02	12.50
	15	10.67	0.43	31.80	45.01	89.71	5.88	7.88	14.69	4.98	6.95	11.99
	20	10.24	0.47	29.94	41.71	82.76	5.10	7.37	13.37	4.71	6.28	11.76
P.F.	10	12.50	0.43	51.31	65.12	81.56	7.25	10.11	17.01	6.11	8.50	13.99
	15	11.80	0.49	48.50	61.29	78.31	6.99	9.56	15.79	5.80	8.20	13.60
	20	11.11	0.53	44.68	58.68	74.63	6.52	8.88	14.63	5.11	7.69	13.08
T.S.P.	10	10.90	0.38	39.59	52.98	89.75	6.34	11.50	18.95	6.80	10.30	16.99
	15	10.60	0.41	37.41	50.69	82.50	5.99	10.33	16.85	6.02	9.99	16.50
	20	10.00	0.49	34.38	46.57	76.46	5.32	9.63	15.80	5.38	9.23	15.38

Table 4 : Comparative physical and mechanical properties of particle boards

	DATE – PALM LEAVES			JUTE - STICK				
	10 %	15 %	20 %	10 %	15 %	20 %		
T.S.P. Binder								
Density (gm/cc)	0.47	0.49	0.48	0.43	0.44	0.48		
Impact Strength (Kgf.cm)	5.80	7.50	8.50	6.00	7.00	7.00		
Tensile Strength (N / mm ²)	1.85	2.10	2.40	2.02	2.82	2.73		
Swelling (%)	9.00	4.90	1hr 5.10	2hr 7.37	3hr 13.37	15.00	7.00	11.50
Average thickness (mm)	12.00	12.00	12.00	13.50	13.50	13.50		

Table 5 : Comparative physical properties of particle boards

UF Resin	Date – Palm Leaf Particle Board			Jute – Stick Particle Board		
	10% /12%	20 %	30 %	10 % / 12%	20 %	30 %
Density (gm/cc)	0.31	0.47	0.65	0.30	0.55	0.70
Impact Strength (Kgf.cm)	5.50	6.05	7.00	5.60	5.90	6.80
Thickness (mm)	11.00	11.00	11.00	11.00	11.00	11.00
Tensile Strength (N / mm ²)	1.70	2.10	2.30	1.50	2.20	2.25

Table 6 : Comparative physical properties of Particle – Boards per unit thickness

T.S.P. Binder	DATE – PALM LEAVES			JUTE - STICKS		
	10%	15%	20%	10%	15%	20%
Impact Strength (Kgf.cm)	0.483	0.625	0.708	0.444	0.519	0.519
Tensile Strength (N/ mm ²)	0.154	0.175	0.200	0.149	0.208	0.202

Table 7 : Comparative study of Physical and Mechanical Properties of Particle Boards from Jute Stick and Date – Palm Leaves

Properties	Date – Palm Leaves						Jute - Stick											
	10%		15%		20%		10%		15%		20%							
P.F. Binder	10%		15%		20%		10%		15%		20%							
Density (gm/cc)	0.43		0.49		0.53		0.42		0.47		0.51							
Impact Strength (Kgf.cm)	7.00		8.10		8.30		6.05		7.50		7.10							
Tensile Strength (N/mm ²)	1.95		2.30		2.50		1.90		2.25		2.20							
Average Thickness (mm)	10.80		10.95		11.00		11.00		11.50		11.60							
Swelling (%) in water	1 hr	2 hr	24 hr	1 hr	2 hr	24 hr	1 hr	2 hr	24 hr	1 hr	2 hr	24 hr	1 hr	2 hr	24 hr	1 hr	2 hr	24 hr
	7.25	10.11	17.01	6.99	9.56	15.79	6.52	8.88	14.63	7.3	10.5	18.0	7.0	8.5	17.5	6.7	9.0	15.0

Table 8 : Standardization of Parameters (Temperature, Pressure and Time) for Development of Particle Boards from Date – Palm Leaves

Temperature: 140°C Time: 20 minute Pressure: 20 Kg/cm ²			Temperature: 150°C Time: 20 minute Pressure: 20 Kg/cm ²			Temperature: 160°C Time: 20 minute Pressure: 20 Kg/cm ²			Temperature: 170°C Time: 20 minute Pressure: 20 Kg/cm ²		
Tensile Strength (N/mm ²)	Flexural Modulus (Mpa)	Impact Strength (Kgf.cm)	Tensile Strength (N/mm ²)	Flexural Modulus (Mpa)	Impact Strength (Kgf.cm)	Tensile Strength (N/mm ²)	Flexural Modulus (Mpa)	Impact Strength (Kgf.cm)	Tensile Strength (N/mm ²)	Flexural Modulus (Mpa)	Impact Strength (Kgf.cm)
1.51	53.38	7.50	1.98	55.41	7.60	2.06	58.48	8.50	2.71	79.78	9.10
1.58	76.48	7.65	2.50	77.50	7.70	2.71	79.78	9.10	2.85	110.68	11.00
1.69	89.80	7.80	2.60	95.31	7.90	2.85	110.68	11.00			

Boards got charred during curing

Table 9 : Comparative Cost structure of Particle – Boards and Boards from Wood material

Particle - Board	Size	Price	Price of 1 c.ft
Date – Palm	(2'x2'x1/2")	20.00	120.00
Jute - Stick	(2'x2'x1/2")	30.00	180.00
Board from wood material	(2'x2'x1/2")	100.00	600.00

made using the phenolic resin show the lowest water absorption (Table 3) and same findings were recorded by many research workers⁵. Thus the results revealed the increased utilization potential of DPL with natural and synthetic resins for the preparation of eco friendly novel products.

Comparative physico – mechanical properties of Particle – Board made from Date – Palm leaves and Jute – Stick using T.S.P. Binder, P.F. and U.F. resins of different concentration were measured⁶ and recorded in Table – 4 and Table – 5 and comparative properties per unit thickness showed in Table – 6. It appears from Table 4, 5, 6 and 7 that Impact strength, Tensile strength, and swelling % of DPL Boards are better than that of Jute – stick particle – boards and swelling % of DPL Boards in water is less as compared to that of Jute – Stick particle Boards. It may be due to the higher ultimate fibre length (1.25 – 2.50 mm), á – cellulose content (about 60%) and good

adhesion between Date – palm leaf particles and resin compared to Jute –stick particles. Table 8 reflected the optimization of Temp, Pressure and Time in relation to the Tensile strength, Impact Strength and Flexural modulus. It may be presumed that, Temperature -160°C, Pressure - 20Kg/cm² and Time - 20 minute for the development of particle – boards from DPL are the optimum physical parameters.

CONCLUSION

About 0.6 million tonnes of Date- palm Leaves (DPL) are available in India every year. Small scale and large scale industries can be set up to produce particle boards across the country at low cost and as substitutes of wood / plywood. Employment generation may be created even in the village sector. There is great demand of the particle – boards throughout India. In this regard, it is worthwhile to mention that the important properties (Viz. Impact- Strength and

moisture content %) reflect sensational findings compared to the existing particle boards from Jute stick. Moreover for higher impact strength and low moisture content %, DPL particle Boards may be used in commercial scale for developing Door / Window panels, Book – Shelf, False Ceiling, Table – Top, Tea – Table, Bed and packaging material (for packing fruits and tea etc.). Regarding cost of the products, it may be predicted that it will 80 % less compared to the cost of wood products available in the market.

REFERENCES

Das, R.N., Day A. & Pandey, S.N. (1987). Particle Board from Jute stick, *Biological waste*, 20, 309.
Das R.N., Day A and Chattapadhyay. (1996). Jute stick particle Board, a wood substitute for various applications - Proceedings of Seminar on Technology today and transfer tomorrow, held on 2nd Feb, 1996 at Ramakrishna Mission Institute of Culture, Golpark, Calcutta.

Ghosh S.K., Saha, S.C., Bhattacharyya S.K. (1993). Chemical Analysis of Date – palm leaf fibre, *Textile Trends*, Vol-36, No- 12, pp 31-36.

Pandey, S.N., Ghosh, S.K. (1995) Note: The Chemical nature of Date – palm fibre in Textiles. *J. Text. Inst.*, 86, No -3, Page -487.

Rowell, R.M., and Banks, W.B. (1985). Water repellency and dimensional stability of wood, USDA Forest Service General Technical Report FPL 50, Forest Products Laboratories, Madison, WI.

Standard and Suggested Methods (1971). Technical Association of the Pulp and Paper industry, New – York, USA.

Received : August, 2005; Accepted : March, 2006

AT LAST! A COMPLETE SCIENTIFIC MAGAZINE

ASIAN SCIENCE