PRODUCTION OF MEDIUM DENSITY FIBREBOARD (MDF) FROM OIL PALM FRONDS AND ITS ADMIXTURE

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Wood-based downstream industry in Malaysia mostly use rubberwood (RW) as their main raw material for manufactured products, and there is high demand particularly from the panel composite sector. Recently, there was insufficient supply due to high proliferation of such industries in Malaysia. The unsecure supply and price hike of RW has led the panel industries to look for alternative raw material.

In 2011, Malaysia had 5 million hectares of oil palm areas. The oil palm biomass generated annually in the form of oil palm trunk (OPT), oil palm fronds (OPF) and empty fruit bunches (EFB) is about 80 million tonnes (dry basis). Out of that, a big portion (about 45 million tonnes) comes from the OPF obtained from pruning and replanting activities. Currently, OPF has not been commercially utilised other than left in the plantation as organic fertiliser. OPF fibre characteristics are better compared to those of the OPT and EFB, which contain unwanted elements such as parenchyma and residual oil that are detrimental to the strength properties of the boards produced from them. From our study, medium density fibreboard (MDF) produced in pilot scale using 100% OPF and blended with RW and mixed tropical hardwood (MTH) exhibited excellent properties compared with commercial products.

THE PROCESS

The prototype MDF boards were produced at pilot scale using 100% OPF and also its mixture with RW and MTH. Blending of OPF with RW and MTH was done after the chipping process. During the refining process, these materials were treated with elevated steam pressure at 5 – 6 bar for 300 s in an inclined digester where the refined fibre was produced. Resin and wax were sprayed onto the fibre using a mechanical blender before forming into mat. The final step was hot pressing where the mat was consolidated at 200°C for 300 s.

The process flow of producing MDF from OPF is presented in *Figure 1.*

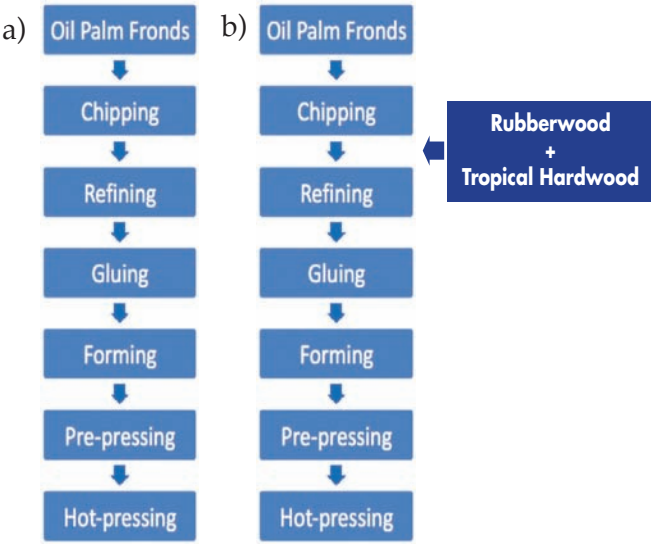

Figure 1. Process flow of medium density fibreboard (MDF) production from oil palm fronds (OPF): a) 100% OPF, b) OPF blended with rubberwood and mixed tropical hardwood.

THE MDF PRODUCTS

The production of MDF using OPF was carried out at MPOB's MDF pilot plant in Bangi. The process parameters for manufacturing the boards are shown in *Table 1.* Most of the parameters particularly the resin and wax content were similar with the commercial plant setting process.

The results revealed that MDF produced from 100% OPF and its mixture offer good mechanical and swelling properties (*Table 2*). Several process optimisations were done and finalised, mainly at the refining stages of OPF fibre to make it suitable for MDF production and to meet the minimum standard requirements.

Fibreboards produced from 100% OPF exhibited excellent results in internal bonding test. The average value of bending tests and swelling

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TABLE 1. SETTING VALUES OF PROCESS PARAMETER

Constant parameters	Value
Steam pressure (refining)	6 bar
Cooking time	300 s
Glue content	9%
Wax content	0.5%

TABLE 2. PROPERTIES OF MDF FROM OIL PALM FRONDS WITH DIFFERENT BLENDING RATIOS

OPF blending ratio	MOE (N mm^{-2})	MOR (N mm^{-2})	IB (N mm^{-2})	TS (%)
100%	2 870.33	32.42	1.12	14.26
5%	2 693.84	32.87	1.17	13.62
10%	3 514.95	43.89	1.05	13.54
15%	3 861.49	44.36	1.26	13.76
20%	3 953.23	45.43	1.28	13.44
EN STD (622-5,2006)	>2 500	>22	>0.6	<15

Note: MOE – modulus of elasticity.
MOR – modulus of rapture.
IB – internal bond.
TS – thickness swelling.

properties fulfilled the requirements as stipulated in European Standard (EN 622-5, 2006). It indicates that OPF is a suitable raw material for the production of MDF.

In determining the properties of partially substituting RW and MTH in panel production, blending ratios of OPF from 5%-20% with RW and MTH was conducted.

Analysis on the boards revealed that the mechanical properties increased with increased OPF blending ratio. The bending test and internal bonding results showed higher values compared with the standard, indicating that the product is suitable for load bearing applications. The water intake values for OPF mixture boards meet the standard requirements. Inclusion of higher amount of hydrophobic substance is required for MDF from OPF for better dimensional stability.

ECONOMIC ANALYSIS

Economic evaluation of this technology is focused on the pre-treatment and mobilisation of OPF. The estimated cost of delivered OPF chips to MDF plant within a 100 km radius is RM 60 t^{-1} whereas for delivered RW, the current price is at RM 130 t^{-1}. OPF cost includes collection, chipping and transportation. *Table 3* shows the comparison of the estimated material cost between OPF and RW. OPF has a lower material cost compared to RW, *i.e.* cheaper by RM 39 t^{-1}. For instance, at 20% OPF blending ratio, it was estimated that for an MDF plant with daily production capacity of 400 m^3, the material cost savings will be RM 3900 per day.

TABLE 3. AVERAGE ESTIMATED MATERIAL COST FOR OIL PALM FRONDS AND RUBBERWOOD

	Oil palm fronds	Rubberwood
Initial M.C (%)	200	60
RM t^{-1} (green)	60	130
Dry weight (t)	0.333	0.625
Dry tonne price (RM)	208	180
Loss (%)(debarking + fine chip)	5	17
Dry yield (t)	0.317	0.519
Price after loss (RM t^{-1})	189	250
Weight at 60% M.C (t)	0.507	0.830
Price at 60% M.C (RM t^{-1})	118	157
Price difference (RM t^{-1})	≈39.00	-

Note: M.C – moisture content, calculation based on 1 t (green).

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