

CHAPTER I

INTRODUCTION

1.1 Background

The timber resource scenario, particularly in Peninsular Malaysia has changed in many respects during the last ten years, and continue to change. In the past, the wood based industries were blessed of having abundant quantities of high quality wood from natural forests. The wood with excellent desirable characteristics was naturally a “ready to use” requiring little processing effort. However, the supply of these timbers have become scarce and no significant supply can be expected from the natural forests in the year to come (Forestry Department Peninsular Malaysia, 2013). Uysal (2005) mentioned that the shortage in timber supply from the natural forests was due to the expansion of new plantation areas for agriculture crops while Alan and Miller (2000), addressed this issue pertaining to illegal logging.

Hence available timber is now generally smaller in diameter and lower in quality than before. Many species that are deemed undesirable in the past are now being used because of a shortage of more desirable species of timber. Due to high demand and short supply, the prices of timber, particularly for the production of sawn timber have increased rapidly and it continues to increase (Forestry Department Peninsular Malaysia, 2012). Table 1.1 shows the amount of log production from the natural forests for respective countries. Thus the dependence of wood industries on fast grown plantation species as the main source of wood is predicted to significantly increase in the coming year (FAO, 2009).

Table 1.1: Estimated amount of log production from natural forest of main exporting Asia-Pacific countries (millions m³)

Countries	Year (million m ³)	
	1998	2010
Malaysia	22	12
Indonesia	40	15
Cambodia	3	1
Papua New Guinea	2	2
Solomon Island	1	0
Total	68	31

Source: Joakko and Ogle/Miller estimates (source from Alan and Miller, 2000)

Apart from forest plantations, another one respond to this situation would be to utilise the lignocellulosics of agriculture biomass that include the felled oil palm trunk (OPT) and rubber tree for some products that have traditionally been made from wood (Salman, 2015; UNEP, 2012). Based on the hectareage of oil palm planted in 1991/1992 and the planting density of 136 palms ha⁻¹, the availability of felled oil palm trunk (OPT) is estimated at 23 million m³ y⁻¹ in the year 2017 to 2018 (Kamarudin *et al.*, 1997). Thus the quantity at hand could act as an alternative raw material to wood in order to satisfy increasing timber demands from the natural forests or forest plantations.

Oil palm tree is naturally a variable material (Tomlinson, 2006; Hodel, 2009; Tomlinson and Quinn, 2013), and therefore, the physical and mechanical properties of the tree trunk are far from homogeneous (Killmann and Lim, 1985; Lim and Gan, 2005; Paridah and Anis, 2008; Kamarudin *et al.*, 2011). Like fast growing forest plantation logs such as *Acacia mangium* (acacia tree) (Krishna *et al.*, 1998) and *Hevea*

brasiliensis (rubber tree) (Kollert and Zana, 1994; Teoh *et al.*, 2011), the conversion of OPT to oil palm lumber (OPL) has to be carried out immediately, as long-term storage may not be economical (Ratnasingam and Scholz, 2012). This is to prevent insect and fungal attacks (Ho *et al.*, 1985; Koh *et al.*, 2009) due to high moisture and starch contents (Halimahton and Abdul Rashih, 1991; Nur Syuhada *et al.*, 2011; Anis *et al.*, 2011).

The biggest challenge is attributed to the small diameter of OPT, which make its handling and sawing difficult compared to large diameter natural forest saw logs. For OPT, the form and sizes rarely exceed 500 mm in diameter at breast height (DBH) when delivered to sawmills (Edi Suhaimi *et al.*, 2006; Anis *et al.*, 2007). Therefore the most common sawing operation to convert OPT into sawn lumber is the live-sawing (also called “through and through” sawing) technique (Ho *et al.*, 1985; Anis *et al.*, 2007; Koh *et al.*, 2009). This method does not require any turning of the OPT, nor special skill in making the cutting decision. It is the fastest conversion method compared to other widely used sawing patterns such as sawing-around, cant-sawing and quarter-sawing (Todoroki and Ronnqvist, 2002).

Since the cutting of OPT does not consider pieces of sawn lumber with defects, the gross sawing yield is highly reduced due to the development of seasoning defects (Ho *et al.*, 1985; Anis *et al.*, 2007) such as are collapse, warping and checks (splits) between vascular bundles and parenchymatous tissues (Koh *et al.*, 2009; Zabler *et al.*, 2010). This might be the results of the cutting pattern used, which is mostly cutting through the pith of the OPT. In general, the OPL cut through the pith of the OPT contains a mixture of higher-density juvenile material in the outer parts together with a lower-density juvenile material in the middle piece (Anis *et al.*, 2007).

Hence the live-sawing technique is most suitable for less defective and large diameter logs from natural forests (How *et al.*, 2007).

Juvenile material in oil palm tree may be described as a zone developing around the pith continuing towards the outer perimeter where its characteristics and properties are subject to gradual changes (Zobel and Sparague, 1998). Consequently, a sawn lumber containing the juvenile woody material tends to give excessive distortions due to the occurrence of differential shrinkage during drying (Maeglin, 1987).

1.2 Recognition of the Problem

In spite of their availability and research findings, the commercial use of OPT for sawn lumber and biocomposite products has yet to reach the desired level. The OPT has high amount of parenchyma tissues (Hallmahon and Abdul Rashih, 1991; Kamarudin *et al.*, 1997; Henson *et al.*, 1999; Nur Syuhada *et al.*, 2011; Anis *et al.*, 2011), and therefore, drying distortions of untreated lumber seemed to be unavoidable (Ho *et al.*, 1985). This will reduce the utility and value of products (Koh *et al.*, 2009). Most of the defective OPT pieces were those from the central region. Therefore, in seasoning of oil palm lumber, the boards from the peripheral zones of the trunk have to be separated from the central region and the use of a fast kiln-drying method for lumber drying (Koh *et al.*, 2009). Drying boards from both peripheral and central zones of the oil palm trunk decreases the overall percentage of sound timber (Anis *et al.*, 2007).

Some of the OPT properties, in particular dimensional stability and durability, are inferior compared to wood (Koh *et al.*, 2009). Dimensional instability, low

mechanical properties and low durability have put it at a disadvantage position in the competitive market. For OPT, the commercial value is determined by a complex interactions between the variations in physical and mechanical properties from butt to crown (Lim and Gan, 2005; Paridah and Anis, 2008), site location and growth characteristics (Cown and Parker, 1978; Morris *et al.*, 1997), processing (Ho *et al.*, 1985; Edi Suhaimi *et al.*, 2006; Kamarudin *et al.*, 2006), and the demands of the market (MPMA, 2007).

Without chemical pretreatment, the OPL is generally susceptible to biodegradation agents such as fungi and wood borers (Ho *et al.*, 1985; Lim and Gan, 2005; Milling *et al.*, 2005). Besides, OPL when exposed to cyclic humidity changes is subjected to unequal expansion in the tangential and radial directions (Sulaiman *et al.*, 2012). This creates internal stresses, which can result in distortion such as checking, warping and twisting (Larson *et al.*, 1983). The dried OPL has low density and subsequently gives lower mechanical properties (Sulaiman *et al.*, 2012). Thus reduces the utility and value of finished products as furniture parts (Ratnasingam and Ioras, 2010).

Sawn lumber is generally treated with chemicals in the form of water repellents and/or preservative to protect it against moisture fluctuation, microorganisms, and ultra-violet (UV) rays in order to improve their dimensional stability (William and Feist, 1999). However, certain chemicals used in traditional water repellents and preservative solutions, such as pentachlorophenol (PCP), copper-chrome-arsenate (CCA) and creosote are toxic to mammals and harmful to the environment (Cooper *et al.*, 2001).

These developments have resulted in significant researches and commercial interest with wood modification technologies such as oil palm stem densification (Killmann and Koh, 1988) and chemical modifications (Robert *et al.*, 2009). The improved characteristics of modified lumber offer many potential and attractive opportunities for the wood industry (Homan and Jorissen, 2004). Hence new methodologies need to be developed in order to process the readily available OPT for sawn lumber productions.

Improvements on the lumber quality through lower rate of dimensional shrinkage during seasoning, and the physical and strength properties of resulting lumber in an environmental benign way is one of the biggest challenges but also an opportunity for wood technologies. For the resin impregnation of a rosin-gum, an innovative vacuum infusion (VI) system, which is specially designed and built for oil palm lumber, was used in this study.

1.3 Research Objectives

The objectives of the study are as follows:

1. To investigate the loading of a gum rosin within the OPL matrix by a vacuum infusion technique, followed by a densification process while maintaining its integrity.
2. To determine the dimensional changes of densified rosin-treated OPL samples in order to provide a preliminary assessment of lumber shrinkage, both in radial and tangential planes.
3. To evaluate the strength properties of densified rosin-treated OPL in relation of matched untreated OPL samples.