Comparative study of polypropylene composites reinforced with pineapple leaf fiber from Josapine and Sarawak cultivar

M.Z. Selamat[1,2,*], A.N. Kasim[1,2], M.A.M. Daud[1,2], M.Y. Yaakob[1], A. Putra[1,2], D. Sivakumar[1,2,]

[1)]Faculty of Mechanical Engineering, UniversitiTeknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[2)]Centre for Advanced Research on Energy, UniversitiTeknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: zulkeflis@utem.edu.my

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ABSTRACT – This paper presents the comparison of mechanical properties of two difference cultivar pineapple leaf fiber (PLF) (Josapine/PLFJ and Sarawak/PLFS) reinforced polypropylene (PP) (copopolymer/PPC and homopolymer/PPH) composite as a function of fiber loading. The samples of PLFJ/PPC and PLFS/PPH composites were fabricated with 30, 40, 50, 60 and 70 wt.% PLF loading with 100 mm fiber length. The fabrication was made by compression molding techniques. The results revealed that composites utilizing PLFJ/PPC shows superior tensile properties as compared to the PLFS/PPH. However, there are no significant disparities observed in the density and hardness of both composites.

1. INTRODUCTION

Malaysia is one of the world's major producers of pineapple, but only the fruit is use and the leaf was burned or through away, thus will cause pollution and wastage of the best potential sources of fiber [1]. Mohamed et al. in 2009 studied characterization of PLF from selected Malaysia cultivars and discovered that Josapine cultivar have the best mechanical properties and quantity of fiber, finest of fibers, thermal stability, tensile strength and modulus compared with Sarawak and Moris cultivars. Table 1 shows the mechanical properties of difference type cultivars of PLF.

Table 1 Mechanical Properties of of PLF [1].

Property	Cultivars		
	Moris Gajah	Josapine	Sarawak
Tensile Strength (MPa)	174.89	293.08	148.44
Young's Modulus (GPa)	7.45	18.94	10.46
Elongation at Break (%)	0.52	1.41	1.05

Due to exponential interest in the development of Biodegradable Fiber Reinforce Polymer (BFRP) composite as an alternative of conventional material such as metal or plastic in product application, Ayu Natasya Kasim et al. in 2015 had studied effect of pineapple leaf fiber loading on the properties of pineapple leaf fiber /polypropylene composite. Kasim et al. [3] have performed alkaline treated of pineapple leaf fiber from josapine cultivar reinforced polypropylene composites. They have examined the effect of fiber loading on the mechanical properties of PLF/PP composite. In the present study, the mechanical properties of PLFJ/PPC were compared over the PLFS/PPH composites.

2. METHODOLOGY

Polypropylene (PPC and PPH) in powder form with size of 250μm produced by Lotte Chemical Titan was utilized as the polymer matrix. The PP had excellent chemical and water resistant, light weight and can be recyclable. PLFJ from Josapine cultivars were collected from cultivation areas in Pontian, Johor Malaysia. The PLFJ were produced by novel technology [4], where the PLFJ were extracted by a decortications machine. PLFS from Perak cultivars were collected from cultivation areas in Perak Darul Ridzuan, Malaysia. The leaf was chopped to a length of 100 mm and extracted with a milling machine. Alkaline treatment was conducted with the aim to improve the mechanical properties and surface modification for both PLF [5-8]. The sample of composites was fabricated with 100 mm fiber length with different fiber loading of PLF (30, 40, 50, 60 and 70 wt.%). After the fabrication of PLF/PP composites was made by compression molding techniques, the samples were prepared for tensile test (ASTM D 3039), hardness test (ASTM D1957) and density measurement.

3. RESULTS AND DISCUSSION

The mechanical properties (tensile, hardness and density) of the PLFJ/PPC and PLFP/PPH composites were evaluated and comparative studies of these properties are shown in Figure 1-3. It was found that the tensile behavior of the PLFJ/PPC composites changes considerably with the increments of PLF loading. Maximum tensile strength up to about 70 MPa has been achieved at 70 wt.% of PLF loading. However, this behavior is contrary for the PLFS/PPH composites, in which the tensile behavior drops drastically with the addition of fiber content. In a realistic behavior, improvement of tensile strength due to the addition of fiber content will induce the reduction of strain properties. However, the results obtained for PLFJ/PPC composite exhibits contradicting effect in which the addition of fiber content improves strain properties as shown in Table 2. The occurrence of this phenomenon might be due to the nature of the Josapine cultivar that

shows superior strain properties as compared to Sarawak cultivars [1]. From the Table 2, it is observed that at 60 wt.% of PLF loading has the highest value of Young's Modulus for PLFJ/PPC while the PLFS/PPH had the lowest Young's Modulus. The addition of 60 wt.% PLF enhances the Young's modulus by 540% for PLFJ/PPC and diminishes the PLFS/PPH by 83.5% as compared to the Young's modulus of plain PP. Additionally, the usage of the matrix plays an important role in composites properties however the effect of different PP types is only at a disparities of relatively low margin. This can be seen clearly from Figure 2 that the tensile strength of PPC had 4.27% more strength than PPH, where the values are 15.46 and 14.8 MPa respectively. Meanwhile for hardness and density of the PLFJ/PPC composites had shown almost similar pattern with the increment from 30 wt.% up to 70 wt.% PLF loading. While, hardness and density of PLFS/PPH composites had shown increment pattern just from 30 wt.% up to 50 wt.% PLF loading as well as the 60 wt.% and 70 wt.% the properties were reduced but at the small percentage. In this study, PLFJ/PPC composites had shown superior mechanical properties as compared to PLFP/PPH composites especially for tensile properties.

Table 2 Tensile properties of PLFJ/PPC and PLF/PPH.

	PLFJ/PPC		**PLFS/PPH**	
PLF (wt.%)	Young's Modulus, E (GPa)	Strain, Ɛ (%)	Young's Modulus, E (GPa)	Strain, Ɛ (%)
0	0.76	5.00	1.70	9.00
30	2.98	3.00	0.36	4.59
40	3.30	3.33	0.64	1.72
50	3.93	3.37	0.51	2.01
60	4.87	3.00	0.28	4.49
70	3.08	5.00	0.37	0.95

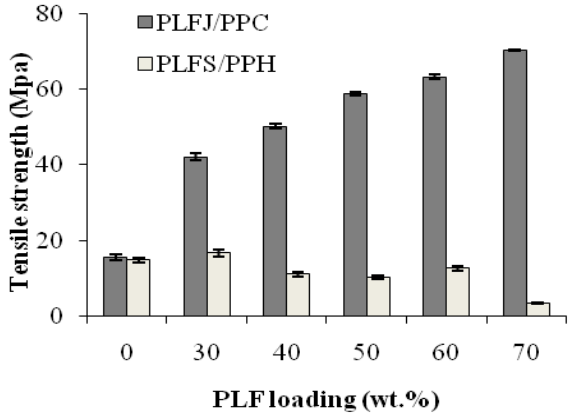

Figure 1 Tensile stress (MPa) vs PLF loading (wt.%).

4. CONCLUSION

The effects of PLF loading on the mechanical properties of PLFJ/PPC and PLFP/PPH composite have been studied and compared. The tensile strength of PLFJ/PPC is much higher than PLFP/PPH composite. Hardness and density for both of composites have shown almost similar result. In short, the present study revealed that PLF from Josapine cultivar was shown a good contender of natural fiber to be used in fabricate natural composite. With the aim of further improvement, the mechanical properties of PLFJ/PPC composite, the addition of bonding agent such as maleic anhydride grafted polypropylene (MAPP) will be conduct.

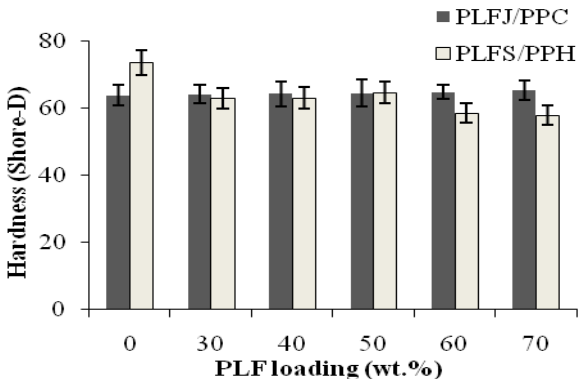

Figure 2 Hardness (Shore-D) vs PLF loading (wt.%).

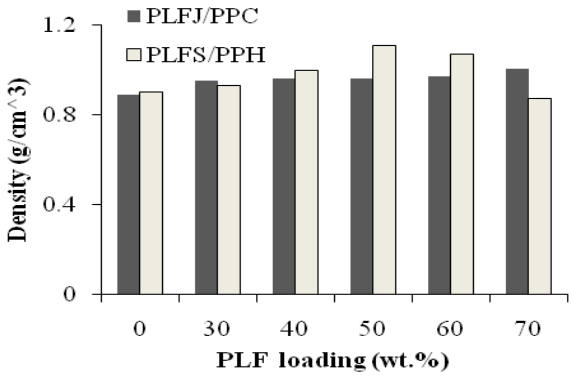

Figure 3 Density (g/cm³) vs PLF loading (wt.%).

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