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CHARACTERIZATION ON MECHANICAL PROPERTIES OF RECYCLED POLYPROPYLENE REINFORCED DRIED BANANA LEAVES DEGRADABLE COMPOSITES

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ABSTRACT

In the fast emerging global, the interest for the environmentally friendly contamination and the prevention of non-renewable and non-biodegradable supplies has enticed researchers pursuing to acquire new eco-friendly resources and products based on sustainability values [1]. Amid the diverse artificial stuffs that have been studied as another to iron and steel for the usage in automotive, plastics declare a major share [2]. In current years natural fibres seem to be the remarkable materials which come as the feasible and plentiful substitute for the expensive and non-renewable synthetic fibre [3]. The fibres from the natural bases stipulate unquestionable compensations over synthetic reinforcement materials perhaps low cost, low density, non-toxicity, comparable strength, and minimum waste disposal problems[1]. Throughout the last era, the research of filled plastic syntheses has replicated huge attention in meeting the deficiency of plastic materials [1]. In the existing experiment, banana fibre reinforced recycled Polypropylene composites are formulated and analyse of these composites are valued. The composite samples with different fibre loadings 0 wt%, 10 wt%, 20 wt%, 30 wt% and 40 wt% were prepared by using melting device and injection moulding process. The samples were subjected to the mechanical properties testing for instance tensile, flexural, and impact evaluation. Scanning electron microscope (SEM) laboratory analysis is performed to evaluate fibre matrix interfaces and investigate the configuration of the fractured surfaces. The study has shown that the finest fibre loading for the highest performance of the composite reached was 30 wt%. This was streamlined further by ASTM where fibres and matrix have shown better well-matched at 30 wt% of treated DBLF.

Keywords: Dried Banana Leaf fibre (DBLF); rPP/DBLF loading; recycling Polypropylene (rPP); preparation; characterisation

INTRODUCTION

The natural fibres are recyclable, non-abrasive, bio-degradable, keep a great calorific rate, expose tremendous mechanical properties and can be annoy for energy improvement have low density and are economical[1]. This fine ecological approach makes the materials very trendy in engineering markets such as the automotive and construction industry[4]. The amalgamation of natural fibres with recycled polypropylene (rPP) increase the tensile and flexural strength and these composites can be depleted for medium intensity usages [5]. Dry banana leaves (DBL), the subject of the present study, is a waste from banana cultivation. Banana leaves are agricultural waste rich in starch and hence used for production of bioplastic[6]. The ripe banana leaf contains 6-9% dry matter of protein, 20-30% fibre and about 40% starch in addition to 88% moisture[7]. Banana produces huge amount of cellulosic waste which is disposed in landfills[7]. As the leaves riot, they produce methane gas which accounts for 20% methane emissions, thus forming a major contributor to global warming [8]. Hence, DBL can be obtained for industrial purposes without any additional cost[5]. In this research recycled Polypropylene (rPP) were used as a matrix and Dried Banana Leaves (DBL) as a functional filler. The different loadings of DBL as a functional filler will be applied which are 0 wt. %, 10 wt. %, 20 wt. %, 30 wt. %, and 40 wt. %. The creation of fibre-reinforced composites is a multistep process. First the DBL is extracted from postharvest of banana itself and DBL will be shredded by using laboratory blender to converted a powder based functional filler. The plastic scrap which is from IM operation, crushed by using industrial crusher to make it in small particles which is denoted as rPP. A series of steps including extrusion and hot-pressing techniques are used to develop the final products. The maximum strength is observed for composites with 30% fibre loading, which is chosen as the critical fibre loading. Over the past decade, cellulosic fillers have been of greater interest as they give composites improved mechanical properties compared to those containing non-fibrous fillers[9]. In recent years, thermoplastics materials have been increasingly used for various applications [3].

MATERIALS AND METHODS

2.1 Materials

The materials are used in this experiment for firming recycle polypropylene and dry banana leaves fibre. rPP that was used as matrix for DBL reinforced composite is a type of recycled homopolymer polypropylene supplied by Titan PP Polymers (M) Sdn Bhd. This polymer is for general purpose of injection moulding. The dry banana leaves were collected from reserved area (forest) IKTBN Sepang, Salak Tinggi, Selangor during housekeeping process.

2.2 Preparation raw materials

All of the prepared rPP are loaded into the crusher machine and the materials were shredded into fine particles. All samples were coded into P1 until P5, as given in the Table 1.

Table 1: Samples of rPP

POLYMER	ʼ1	P2	P3	P4	P5
rPP, wt %	100	90	80	70	

The prepared DBL are filled into the industrial crusher and the DBL were grinded into fine grains. All samples were coded into B1 until B5, as given in the Table 2.

Table 2: Samples of DBL

Dried Banana Leaves	B1	B2	B3	B4	B5
DBL	0	10	20	30	

2.3 Samples Preparation

In preparing the blends, the rPP and DBL are weighted according to the blend's formulation recipes. The ratio of compounding blends materials is calculated by using the formula as mentioned in the Equation 1. As an example, Equation 1 shows the calculation to produce P4/B4 sample, when the weight percentage of rPP is 70% and weight percentage of DBL is 30%.

Equation 1,

rPP = (70/100) X 1000g

= 700g

DBL= (30/100) X 1000g

= 300g

Similar calculation procedure was applied for all the formulation batches.

2.3.1 Crusher rPP

Plastic materials that were used in this research are the recycled PP from Injection Moulding (IM) process. The materials then were prepared by crushing the material into the crusher machine to convert them into smaller particles.

2.3.2. Grinding DBL

This fine blended appears to be the most suitable processing size for melt mixing which give effective reinforcement in PP [1]. DBL fibres will dried up in electric oven. The drying process will be executing for 30 minutes at 50°C to remove the moisturization.

2.3.3 rPP/DBL Composite Preparation

Melt mixing method was used to mix rPP and DBL. Various compositions of rPP and DBL were compounded in Melting Device. Table 3 indicates different fibre loadings that are presented in the rPP matrix.

Table 3: DBL reinforced PP composites Composition

Ingredient	Composition (%wt)				
	P1/B1	P2/B2	P3/B3	P4/B4	P5/B5
Recycled Polypropylene (rPP)	100	90	80	70	60
Dried Banana Leaves (DBLF)	0	10	20	30	40

Composition of rPP and DBL were weighted accordingly and melt mixed for a period of 30 minutes at temperature 180° using melting device. The temperature was used as the optimum processing temperature for rPP matrix but not exceeding that. Higher temperature would result in a reduction in strength and modulus which may be due to the degradation of fibre. In addition, dispersion of DBL in PP matrix will be poor as there is a drop-in viscosity at high temperature. The compounded composites were shoot up by injection moulding with thickness 3mm according to the specs that required in testing sample.

RESULT AND DISCUSSION

The main idea of this research is to explore how the weight percentage ratio of two structures of recycled materials of rPP and agriculture waste DBL would influence the properties of blends for potential packaging application. The weight percentage DBL are varied into 0 wt %, 10 wt %, 20 wt %, 30 wt % and 40 wt %. From the testing, the ultimate tensile strength, Young's modulus and the percentages of elongation at break of resulted mixture blend materials can be measured. The following Figure 4.1 shows the ultimate tensile strength result of various weight percentages ratio of hybrid materials of rPP and DBL.

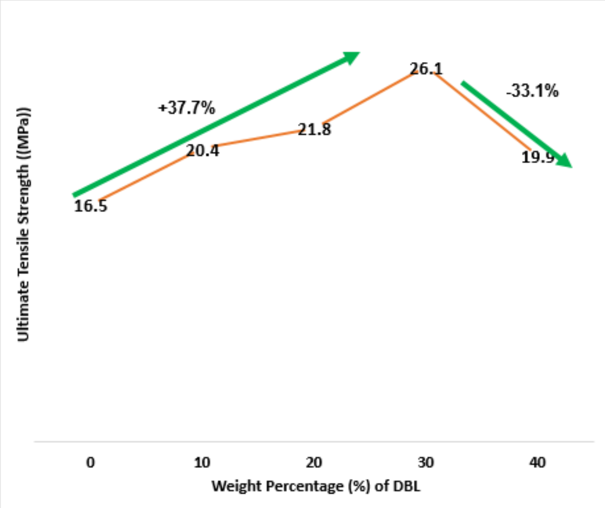

Figure 1: The Effect of Different Weight Percentages Ratio Between rPP and DBL Composition into the Ultimate Tensile Strength of rPP/DBL Blend

Tensile Testing

Figure 1 indicates the rapports between fibre content and tensile strength. From this figure, it can be seen that tensile strengths improve directly with increasing fibre content. The tensile strengths were 26.1 MPa, in the samples with a fibre portion of 30%. When fibre content is more than 30%, some voids and fibre contacts affected by inadequate amount of resin are experimental in the specimen. Therefore, the fibre content used for producing DBL fibre reinforced composites should be kept below 30%.

Flexural Testing

The flexural testing used in this research was three-point bending test. A flexural property is to determine the stiffness behaviour of blended rPP and DBL materials. Flexural strength is increased when the filler content increased Figure 4(a) shows that the value of flexural strength. The bending strength is increased when the filler content increased for 0 wt. % to 10 wt. %, but it is decreased for 20 wt % to 40 wt. %. Theoretically, the strength value must increase when the filler for 0 wt. % to 30 wt. %, but it is decreased for 40 wt. % [2]. However, in this experiment, the value must increase when the filler content is 30 wt. %. Most probably reason is because the material was not properly blended when mixing process carried out, where the strength value of samples is supposed to be higher than rPP material when the filler is added to 30 wt. % content.

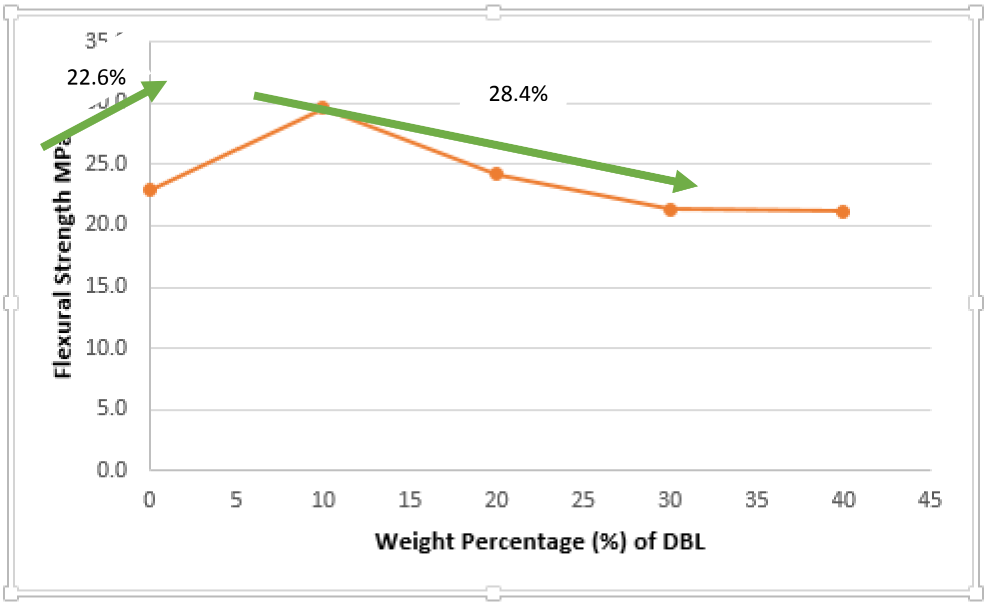

Figure 2: The Effect of Different Weight Percentages Ratio Between rPP and DBL Composition into the flexural Strength of rPP/DBL Blend

Scanning Electron Microscope (SEM)

In order to evaluate the morphological changes of the rPP/DBL polymeric blends, the samples were subjected to scanning electron microscopic (SEM) observation as shown in the following Figure 3. To achieve good electrical conductivity, these samples were first gold sputtered and then line of silver has been made from the surface along the edge of the sample before examination. The morphology of compatibility polymer blends is depended on the component, ratios, melts viscosities component and their processing conditions. In most of the heterogenous blend system morphology where by one phase is distributed in another phase is observed [3].

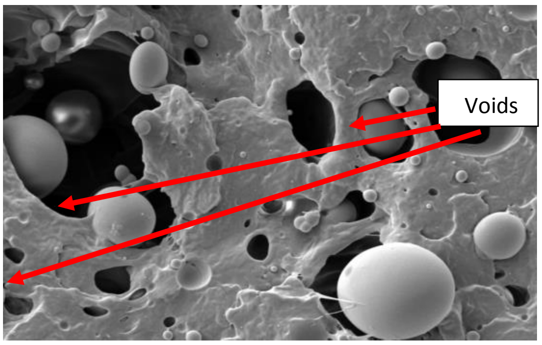

Figure 3: Fracture Surface of rPP

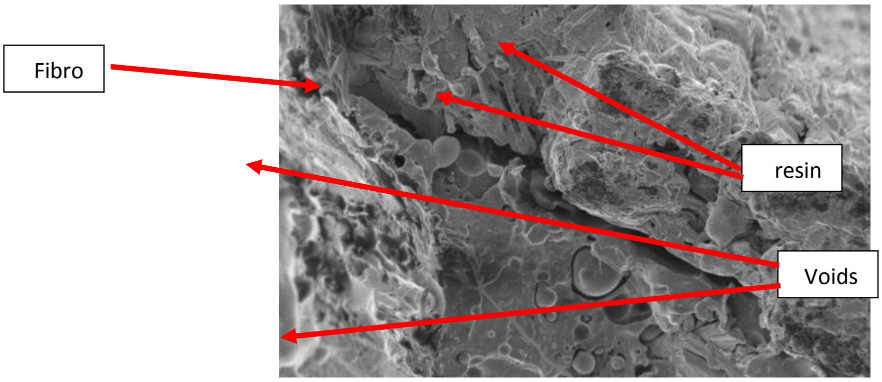

Figure 4: fracture surface of rPP /DBL blend

Micrograph at the following Figure 4 shows the fracture surface of rPP /DBL blend samples at different composition of rPP and DBL phases which are 100 wt. % of rPP, 10, 20, 30, and 40 wt. % of DBL. The SEM micrograph of rPP/DBL blend at wt. % of 70/30 blend ratio has indicated rougher surface as shown in the following Figure 4. The 60/40 wt. % of rPP/DBL micrograph has clearly indicates that the rPP and DBL are incompatible towards each other.

CONCLUSION

From the study conducted on the effect of filler content on the mechanical properties and the microstructure of the rPP/DBL Composites, the following conclusions were drawn:-

i The optimal value for tensile strength was obtained at filler loads of 30 wt. of DBL.

ii The flexural strength of the composites was influenced by increase in filler content

iii The SEM result of the fabricated composite revealed that the fillers were uniformly segregated, there was some compatibility of the fillers with the matrix except for some voids observed for some of the formulations.

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