RECENT DEVELOPMENT IN SUGAR PALM (*ARENGA PINNATA (WURMB) MERR*.) REINFORCED POLYMER COMPOSITE RESEARCH

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ABSTRACT

In this paper an overview of sugar palm (Arenga pinnata (Wurmb) Merr.) research and development is presented. The use of sugar palm products had been so far targeting on food industry such as in making syrup, sugar and delicacies. Sugar palm fibres are also reported to be used in making traditional products like roof, broom, brush, and ropes. Advanced application of sugar palm fibres is mainly for reinforcements in polymer composites. The development of biopolymer from sugar palm starch has led to 100 % bio-based composites, i.e. sugar palm filled sugar palm starch biocomposites.

I. INTRODUCTION

In the recent years, research on natural fibre reinforced biopolymer composites have been intensified and a lot of interesting findings have been reported, all towards achieving 'green', environmentally friendly and sustainable materials and products. A lot of works have been devoted to development and characterization of natural fibre reinforced polymer composites, where the polymers were synthetic polymers like epoxy, unsaturated polyester, polyurethanes, polypropylene and polycarbonate (Sapuan, 2014). Natural fibres like kenaf, hemp, jute, sisal, flax, oil palm, date palm, sugar palm, banana pseudo-stem, pineapple leaf, roselle, abaca, sugarcane, rice hush and betel nut husk had been reported to be used as reinforcements and fillers in biopolymer or synthetic polymer composites. The major problem resulted from the use of natural fibre composites include high water absorption, interfacial bonding between fibres and matrices and low strength and stiffness properties. Therefore, their use is only restricted to non-structural components due to their inherent low mechanical properties and the requirements of treatment and coupling agents to enhance interfacial bonding between fibres and matrices (Agung et al., 2011).

1.1. Sugar Palm (*arenga pinnata* (*wurmb.) Merr.*)

1.1.1. *Sugar palm tree*

Sugar palm trees are normally found in Malaysia and Indonesia. They are considered multi purpose trees as all parts of the trees can be made into useful products, The tree is known as *enau* in Malaysia, *aren* in Indonesia, and *gumoti* in India, while its fibres are known as *ijuk* in Malaysia and Indonesia (Mogea et al., 1991; Sanyang et al., 2016a; Ishak et al. (2013).

1.1.2. *Traditional use*

Sugar palm (*Arenga pinnata (Wurmb) merr*.) is a tropical tree (see Figure 1), and its previous use was mainly devoted for food products such as palm sugar and saps, toddy, delicacies, and syrup (See Figure 2). Limited use of the fibres had been reported for making traditional products such as ropes, brushes, headgears, roofing, cordage and brooms.

Figure 1: Sugar palm plantation

Figure 2: Sugar palm syrup (Courtesy of Kebun Rimau Sdn. Bhd. Balung, Tawau, Sabah, Malaysia)

1.2. *Arenga Pinnata (wurmb. Merr)* fibres

The utilization of sugar palm fibres had been investigated by our research group. The work was carried out in collaboration with a company producing sugar palm fibres from Tasikmalaya, West Java, Indonesia. The aim of the work is mainly focusing on knowledge transfer to the community based on sugar palm products. The community selected was a group of villagers, who are trained to develop traditional products from sugar palm fibres. We are working together to produce simple products such as brooms, ropes (Figure 3), roofing (Figure 4), fibres, and brushes and attempts have been made to commercialize them.

Figure 3: Sugar palm ropes (Courtesy of Mr Indra Yana, CV Sumber Mulya, Tasikmalaya, West Java)

Figure 4: Roofs for a Mosque made from sugar palm fibres in Kampung Naga, Tasikmalaya, West Java

1.3. Sugar Palm Fibre Reinforced Polymer Composite Product Development

Another use of the fibres is as reinforcement in polymer composites. An example of such work is on the development of sugar palm/glass fibre reinforced polyurethane hybrid composite automotive anti roll bar (see Figure 5). The work is carried out in collaboration with an established Malaysian automaker. We carried out testing and characterization of materials, came up with conceptual design, carried out design analysis, performed materials, manufacturing process and design concept selection, carried out impact testing, and fabricated prototype.

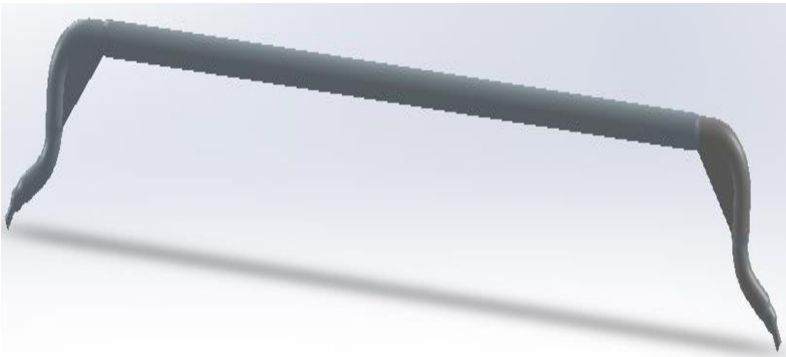

Figure 5: A model of hybrid sugar palm-glass fibre composite automotive anti-roll bar

1.4. Biopolymer From *Arenga Pinnata (Wurmb) Merr.)*

The most recent use of sugar palm is as biopolymer from modified sugar palm starch. The biggest challenge in this research is to obtain enough trees to be cut in order to extract the starch. Malaysia, source of starch from the tree is found to be very difficult to be extracted. Manual cutting of the trunk using chain saw is very tedious and extracting the starch from the core is very unpleasant and may require specialized machine that may be costly. Our research group has been able to overcome some of these problems (See Figure 6). We have involved in supplying such starch for various institutions as biopolymers in our colleagues' work on biocomposites.

1.5. *Arenga Pinnata* Fibre Reinforced *Arenga Pinnata* Starch Biopolymer Composites

There are still a lot challenges in using sugar starch based polymer composite products such as films. The challenges of using sugar palm fibres in composites include the inherent drawbacks associated with starch based films such as brittleness, poor water vapor barrier and high moisture sensitivity which in turn limit their wide application in the packaging industry. In order to address such drawbacks, three modification techniques were employed in this study: (1) plasticized with different plasticizers and concentration, (2) incorporated with another polymer or (3) reinforced with cellulose fibers to enhance functional properties of the resulting sugar palm based films. Consequently, sugar palm starch (SPS) films were successfully developed using solution casting method and the sugar palm fibres were added to the SPS to form 100% biodegradable biopolymer composites. Mechanical, physical, thermal, environmental and morphological characterization and testing of such composites were extensively carried out the results were very promising and these sugar palm fibre/SPS based film composites are particularly suitable for food packaging (Sanyang *et al.*, 2016).

Figure 6: Extraction of sugar palm starch

II. CONCLUSIONS

Description on the use of sugar palm products was presented. Sugar palm has huge potential for commercialization either in the form of fibres, starch, food products as well as sugar palm composites. This move can help boosting economic level of people living in rural areas through fabrication and sale of wide ranges of products from sugar palm trees.

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