SUGAR PALM FIBER: FROM TRADITIONAL TO ADVANCE APPLICATIONS

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Introduction

Renewable and biodegradable materials are the hope of the near future. The devastating environmental issues generated by petroleum-based materials can be eliminated or at least minimized with the corporation of natural fibers and biopolymers in composite materials. The development of such green composites can yield significant environmental improvements, address plastic waste disposal and the reduction of carbon footprint of petroleum-based materials. For better sustainable future, bio-resources are increasing being utilized as potential alternatives for non-biodegradable synthetic materials. Abundant availability and low cost of these green materials grant them much attention for the past few decades.

Sugar palm *(Arenga pinnata)* is a multipurpose tree with several traditional uses. Different components of the tree have been extensively used for making numerous local products. Due to their outstanding mechanical properties, sugar palm fibers can compete with most natural fibers in the market such as coir, oil palm fiber, kenaf, cotton, jute and many more fibers.

Traditional uses of sugar palm fiber

The durability and resistance of sugar palm fiber to sea water resulted to their widespread usage in rural areas for manufacturing many traditional products (Figure 1). Martini et al. (2012) reported that different ethnic groups in Indonesia utilized sugar palm fiber for different purposes depending on their socio-economic activities, market opportunities and availability of other natural resources. Overall, the fiber immensely contributes to human livelihood in Indonesia, Thailand, Cambodia, Philippines etc. The fiber can be manually spun unidirectional to make ropes, or woven into mats. Traditionally, it is proven to be a suitable material for making ship ropes, brushes and brooms. It is also identified by the villages as one of the best options for traditional roofing and bridge construction which can withstand tropical climate for many years (Ticualo et al., 2013).

Figure 1: Traditional uses of sugar palm fiber

Applications of Green biocomposites from sugar palm fibers

Automotive Application

On the basis of sustainability, renewability, and affordability, biocomposite is a highly promising material for the automotive industry. Hence, there is an on-going research on the fabrication of glass/sugar palm fibre reinforced polyurethane hybrid composites as an anti-roll bar for sedan vehicles (Figure 2). This investigation is an innovation towards a greener future. The use of biobased anti-roll bar in vehicles will promote sustainability, reduce the car's consumption of fuel and emission of CO_2 as well as addresses the negative impact of non-biodegradable plastics and fibers on the environment (Muscat et al., 2012). Thus, glass/sugar palm fibre reinforced polyurethane hybrid composites anti-roll bar is a potential alternative to conventional anti-roll bars. In one word, this research has presented a new perspective to sustainability research related to the automotive industry.

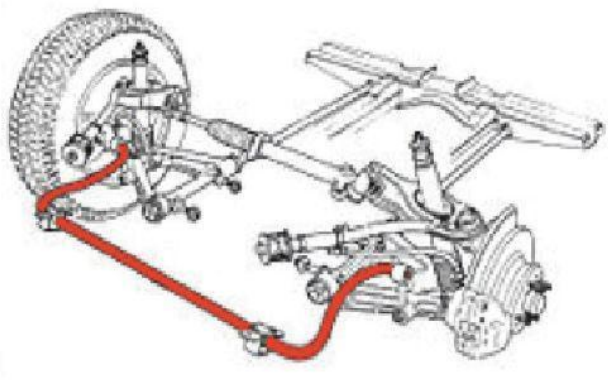

Figure 2: Antiroll bar to be fabricated from glass/sugar palm fibre reinforced polyurethane hybrid composites

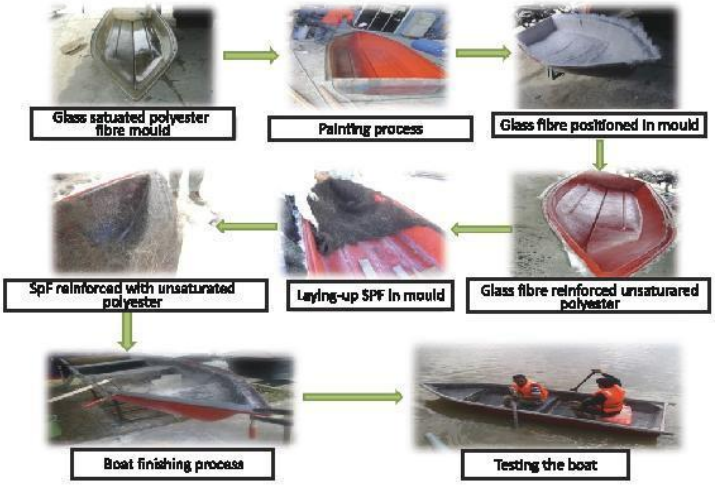

Figure 3: Fabrication of sugar palm/glass fiber hybrid boat (Sanyang et al., 2016a)

Marine Application

Sugar palm fiber is long since known for its resistance to seawater, as such, the rural fisher men often use it as a rope to tie small boats. In support of this custom, Leman et al. (2008) treated sugar palm fiber with seawater. They reported that the mechanical properties of the treated fiber employed to reinforce epoxy composites increased by soaking it in seawater for 30 days. Subsequently, Misri et al. (2010) fabricated a 12 feet (length) hybrid composite boat from the combination of sugar palm and glass fiber with unsaturated polyester as the matrix (Figure 3).

Packaging Application

Biopolymers (bio-based polymers) are considered biodegradable but not all biodegradable polymers are biopolymers. Reinforcement of the biodegradable materials with natural fibers yield improved material properties desired in various applications without compromising their biodegradability. When both the fiber and matrix are from renewable resources, the resulting composite material can be referred to as "100% bio-based biocomposites" or "fully biodegradable green composite" (Vilaplana et al., 2010). The use of such biocomposites should be encourage for less environmental impact.

In the case of sugar palm, starch can be obtained from the inner core of the trunk. Number of studies has been reported on the suitability of sugar palm starch for preparing shopping bags and food packaging films (Sanyang et al., 2016a; 2016b; 2016c) (see Figure 4). Starch based films are renewable and 100% biodegradable material and are potential replacement of non-renewable packaging films. However, the main water, which can be attributed their hydrophilic and hygroscopic nature as well as the high plasticizing effect of water (Olsson et al., 2013). In general, these films are considered to have moderate oxygen barrier properties but poor moisture barrier and mechanical properties, which limit their wide applications for food packaging. Therefore, the development of packaging materials with good barrier against water and acceptable mechanical strength is a primary concern in the food packaging industry. On these bases, a recent study was conducted by Sanyang et al. (2016c) in which sugar palm-derived cellulose (SPC) composites were prepared and utilized as reinforcement material to improve the mechanical and water vapor barrier properties of sugar palm starch (SPS)-based films. The incorporation of 1 wt. % SPC loading significantly improved the water vapor permeability (WVP) of the composite film by 63.53%, thus, enhance their suitability for food packaging applications.

Figure 4: Potential applications of sugar palm based biocomposites for shopping bags and food packaging materials

Conclusions

Most interestingly, 'one-source' green composite can be fabricated by 'marrying' natural fiber with biopolymer from a single sugar palm tree. In general, use of sugar palm fiber and starch in green composites can help in: (1) reducing the negative environmental impact of synthetic polymers and fibers; (2) decreasing the pressure for the dependence on petroleum products; and (3) developing sugar palm as new industrial crop in the future, most especially in tropical countries. Consequently, this can lead to better socio-economic empowerment of the rural people by increasing revenues and creating more job opportunities. However, the gigantic opportunity of utilizing sugar palm fiber and biopolymer in the composite industry for various potential industrial applications has not been widely exploited.

Future perspectives

So far, substantial works were done on sugar palm based composite but there is no reported investigation on sugar palm based nanocomposites. Venturing into sugar palm nanocomposites can enhance the reputation of sugar palm biocomposite industry and open new markets such as pharmaceutical and electronic packaging. This is a virgin research and innovation area to address some concerns hindering potential industrial applications of sugar palm fibers, biopolymer and their composites.

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