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SUGAR PALM LIGNOCELLULOSIC FIBER REINFORCED POLYMER COMPOSITE: A REVIEW

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Abstract. *The increasing depletion of petroleum resources, as well as increased awareness of global environmental problems linked with the usage of petroleum-based plastics, are the key driving factors for the widespread acceptance of natural fibres and biopolymers composites. Sugar palm fibre (Arenga pinnata Wurmb. Merr) is one of Malaysia's most abundant and renewable fibres. The purpose of this paper is to explore the development of a sugar palm lignocellulosic fibre reinforced polymer composite. SPF is mostly composed of cellulose (43.88 %), which results in good mechanical properties. According to the review of literature, no comprehensive review article on sugar palm lignocellulosic fibre reinforced polymer composite has been published. The current investigation is focused on the mechanical, thermal, and morphological aspects of SPFs and polymers. The research also demonstrates the potential of SPF polymer hybrid composites for industrial applications such as automotive, household goods, packaging, bioenergy, and others.*

Keywords: *Sugar plam fiber; lignocellulosic fiber; polymer composite,*

1. Introduction

Sugar palm is popular in Malaysia, particularly in the state of Negeri Sembilan, with the action of tapping as the material palm sap for producing or kabung sugar cubes [1,2]. Until now, many neighborhood palm sap tappers are still gaining income by producing conventional sugar cubes [3]. It can be processed to producing sugar cubes and might be processed to be as a substitute to the sugar. Additionally, it may be fermented to produce bioethanol for production of choices of products (compound products, additives, additives, medications, beverages, etc.) and can also be utilized to make biofuel. The step following palm sap is its fruit. It might be processed for being

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cooked for generating peppers, and generating juices for meals, pickles. However, the primary part after its palm sugar and its fruit is its fiber. There are three main benefits of sugar palm fiber; it has high tensile strength and can withstand a lengthy lifetime; is not influenced by moisture compared with coir fiber, it is lasting and outstanding resistance to seawater. Traditionally, the sugar fibers were used for making ropes for vessel cordages and known to own unique properties in seawater. It is due to those fibers were originally wrapped round the base of the palm leaf ribs. Consequently, the fibers may be utilized by which their fibers are readily in the form of fibers. Moreover, the increase of interest in utilizing organic fiber as composite reinforcement is one of these factors that encourage the use of sugar management fiber [4]. Several studies have now been finished into the properties of sugar control fiber and its composites to reveal its performance and to promote its use to the customers and companies. Continuous research was finished and has found that the sugar palm fibers have outstanding potential to be used as reinforcement in polymer composites rather to glass fiber [5]. Since organic fibers are organic materials, they exhibit significant variability in their own possessions. It has generated difficulties in the use of sugar palm fiber for generating high quality and performance of composite products. Focus is offered on the balance, although studies of bio composites are concentrated in their own properties. A number of experiments have been finished and have shown that thermal properties provide a significant participation in understanding the behavior of the fibers and composites [6][7].

The use of composites has a vital role as substitution substances for many others in a variety of areas of application like automotive and construction [8,9]. That the dependencies towards fibers glass is not enough, moreover the downsides of those fibers that exceptionally in substances material and cost. Natural fiber psychologist is the right substitute for artificial fiber within an application. The components are appearing as eco-friendly, light weight, recyclable and cheap material with renewable resources and very lower density. Despite all such advantages, most of the fibers tend to create aggregates throughout the process as a result of corrosion immunity and heating resistance. As the alternative may be regarded from the combination as an all-natural fiber for reinforcement. Along with this study, sugar is considered fresh and far to be researched as reinforcement at a mix.

As for polymer, the conductive substance is thought of as the ideal option in duration of "green technology" because of five elements theory that favors the recyclable material instead of thermoset material. As a polymer molecule exhibits reaction plus period the thermo plastic normally performed badly in loading. Of thermo-plastic, Polypropylene (PP) is just a cheap industrial material, light weight, durable, ecofriendly and simple to process. The properties have district features contingent up on cellulose content that changes from fiber. As the components in combination, the port between matrix PP and reinforcement sugar fiber is as a result of the compatibility. That is only the reason the traits of the majority of natural fibers behave as water and brought to water (hydrophilic) that contrasts with hydrophobic substances of PP. The bond between reinforcement and matrix has caused lack of mechanical properties of PP composites due to the increment quantity of voids and also appearance of moisture. The top treatment is introduced to enhance the components of this publication to overcome those flaws faced with natural fibers polymer-based blend. Predicated in the literature inspection that was last the sugar fiber reinforced polypropylene composites deficiency usually and being exposed to surface treatments being treated with therapy.

As physical properties, the features of fiber that tend retain and to consume the moisture contribute to cons of the composite. The component of this publication must be plotted to conquer the lack. Being the fiber composites had paid down the individual trait of material such as mechanical and mechanical properties. Hence, better mechanical properties cannot be achieved by the green composites. Due to that, the use of pure green or fiber composite as the replacement to synthetic fiber composites seem by improving the structure and the interface of fiber, do-able.

2. Methods

2.1 Sugar Palm

Sugar Palm is a common name given to several species of palm trees used to produce sugar. Sugar Palm is known scientifically as (*Arenga Pinnata*) [10] . According to Leman et al. [11], the sugar palm tree is not only limited to the creation of sugar. Additionally, a lot of different assortments of consumable products, wood commodities, Biomaterials could be created.

Sugar palm has a place with the sub-group of Arecoideae and the clan of Caryoteae. It was before given various scientific categorisations, for example, *Saguerus rumphii* and *Arenga saccharifera Labill*. Be that as it may, the International Congress of Botany in Vienna, it was formally renamed as *Arenga pinnata*. As a member of the Palmae family, it has the potential to be a fast-growing palm that can fully develop in 10 years [10]. SP tree is well known to local Malaysian as enau or kabung. Geographically, the wild plant species covers up to South Asia.

2.1.1 Characterization of Sugar Palm

The characterization of sugar palm is conducted with many additives and composites. The improvement and portrayal of naturally well-disposedbilayer films from sugar palm starch (SPS) and poly (lactic corrosive) (PLA)were led in this examination. The SPS-PLA bilayer films and their segmentswere portrayed for their physical, mechanical, thermal and water hindrance properties

[7].

Addition of half PLA layer onto half SPS layer (SPS50-PLA50) expanded the rigidity of perfect SPS film from 7.74 to 13.65 MPa however decreasedtheir stretching at break from 46.66 to 15.53%. The consolidation of the PLA layer fundamentally diminished the water vapour porousness just as the water take-up and solubility of bilayer films which was ascribed to the hydrophobic normal for the PLA layer. Furthermore, the scanning electron microscopy (SEM) picture of SPS50-PLA50 indicates the absence of stableinterfacial adhesion between the SPS and PLA. In general, the joining of thePLA layer onto SPS films improves the suitability of SPS based movies fornourishment bundling [7].

Another growth and characterization was done by Ilyas et al. [12] on nanocrystalline cellulose SPF were medicated by $NaClO_2$, blanched with NaOH and thus hydrolyzed with infantry to obtain sugar palm nanocrystalline cellulose. Bio nanocomposites as movies were set up by blending SPS together with sorbitol/glycerol with various SPNCCs pieces from 0 to 1.0 weight% utilizing arrangement throwing technique.

The subsequent filaments and nanocomposites were described regarding morphology, crystallinity (XRD), FTIR, the biodegradability, water boundary, thermal (TGA, DSC and DMA), physical and mechanical properties. The SPS/SPNCCs nanocomposite films shown higher crystallinity, rigidity, Young's modulus, thermal and water-obstruction contrasted with the slick SPS film. The outcomes demonstrates the stiffnessand the modulus obtained from the bio nanocomposites expanded after being fortified with SPNCCs and the ideal nanofiller content was 0.5% [12].

On another evaluation conducted where cellulose was eliminated in sugar palm filaments by top delignification and mercerization treatment. Alongsuch lines, sugar palm nanocrystalline celluloses (SPNCCs) were dispersed in the extricated cellulose using 60 wt% concentrated sulphuric corrosive [14]. The substance synthesis of sugar palm strands was resolved at various phases of treatment. The auxiliary examination was done by Brunauer-Emmett-Teller (BET), X-beam diffraction (XRD) and Fourier change infrared spectroscopy (FT-IR).

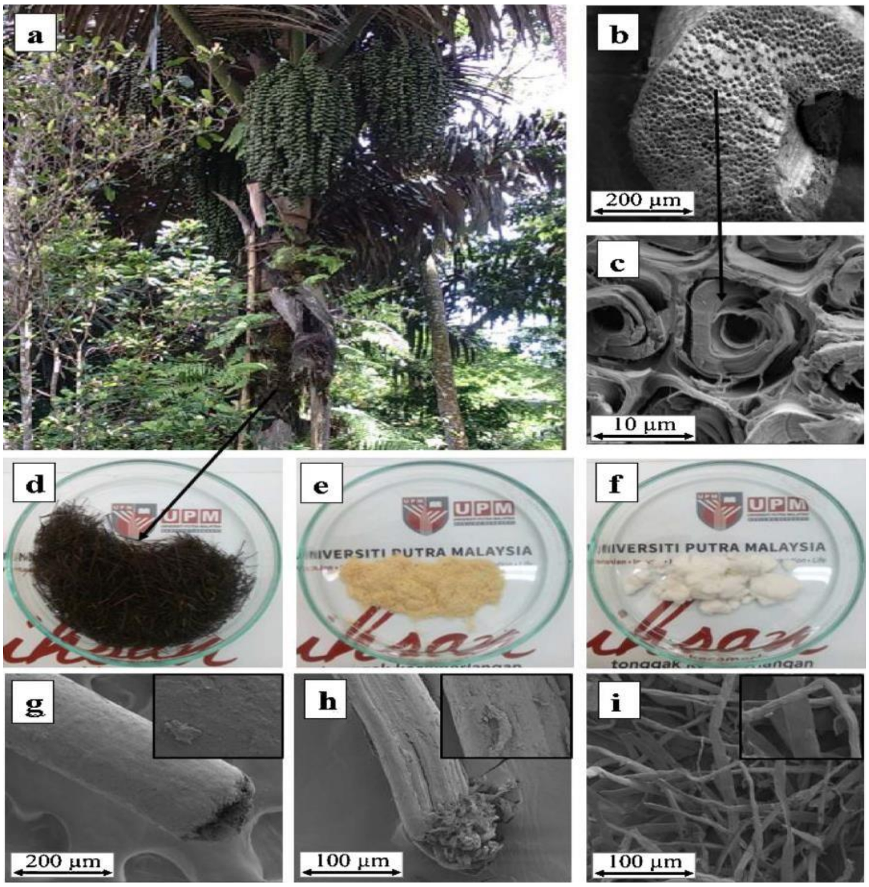


Figure 1. Photographs of (a) the sugar palm tree, (d) raw sugar palm fibers, (e) bleached fibers and (f) alkali-treated fibers; FESEM micrographs of sugar plant fibers: (g) cross-section, (b)longitudinal section, (c) primary, secondary cell wall and middle lamella, (h) alkali-treated fibers, (i) andbleached fibers [12]

Morphological evaluation of extricated cellulose and dispersed nanocrystalline cellulose (NCCs) has been analyzed by using field emanation assessing electron microscopy (FESEM), atomic energy microscopy (AFM), and transmission electron microscopy (TEM) [12]. The arm solidness of sugar palm strands in different phases of therapy was analyzed by thermogravimetric analysis (TGA). The results demonstrated that hemicellulose and lignin were expelled in the cellulose throughout the mercerisation and delignification procedure. The restricted SPNCCs were discovered to get dimensions and length of 130 ± 30 nm and 9 ± 1.96 nm, individually [14]

3. Multipurpose of sugar palm

Sugar palm plant standout amongst the adaptable palm family due to its utilization of all parts. Aside from the palm sap, other huge things that can be created from sugar palm which is palm neera, conventional sugar squares,crisp juices, precious stone hard stuff, and dark-coloured sugar, vinegar, bio-ethanol, starch from trunk, ocean water safe fiber, consumable heart, natural products, leaves for material, floor brushes, tangling, bushels, cigarette papers, steers encourages, and it is starch inside the stem can be prepared to make biopolymer [10]. The sugar which is extracted can be used for cooking and baking. It also can be substitution forthe household sugar which is produced from sugar cane. Most of parts of thetree are not well utilized whereby most of the farmers from Malaysia and Indonesia just use the plant to harvest sugar.

4. Bioethanol from sugar palm

Sugar Palm sugar also evolve to different dimension whereby palm sugar isused to make alcohol drinks. Bioethanol is utilized as crude product for items, for example, concoction items, solvents, pharmaceutical, makeup, and medications. Palm sugar can likewise utilize as the generation of biofueldue to its inexhaustible production of vitality. It is fascinating to take note of that sugar palm can yield the most astounding profitability of bio-ethanol (20,160 l/ha/year) contrasted with different sources for example, cassava (4500 l/ha/year), sugarcane (5025 l/ha/year), sago (4133 l/ha/year), and sweet sorghum (6000 l/ha/year) [10]. Extensive scale commercialization of sugar palm estates which is as wide as 800,000 ha to 4,000,000 ha are currently advancement, particularly in Indonesia to utilisethis gigantic capability of SP plants.

5. Sugar Palm Fiber

Sugar Palm fiber is one of the significant materials that is produced from the plant. The fiber is well known as ijuk fiber by the locals. The use of the fiber was started when Malacca Sultanate time. The British East India Organization in Penang start planting the trees in 1800 to create high solidness rope produced using its fiber. This multipurpose fiber can be usedto make various items, for example, strings, channels, brushes, floor brushes,tangles, pads and safe houses for fish rearing.

The fiber of sugar palm is famous among the fisherman due to its resistanceand durability against ocean weather condition. The fiber was basically usedas ropes for the ship which illustrate the properties of the fiber towards sea condition. Furthermore, the production of the rope is easy as the fiber do notthe needs of auxiliary procedures, for example, water retting or mechanical decorticating procedure to yield the fiber. This is due to the way that the filaments, folded within the sugar palm back from the bottom into the bit ofthe shrub, are as regular fiber that is woven.

The tree starts to deliver fiber before blossoming around the next followingfifth year. SPF is dark and the length will be approximately 1.19m [10]. Its breadth goes somewhere in the range of 94 and 370 m and itsthickness are 1.26 kg/m^3. The SPF quality are impacted by the existence ofit and elevation of SP tree. The SPF have thermal tolerance ability up to 150 ^{o}C. The SPF are differentiated into five grades which is from grade A to grade E whereby the last grade will be the king of SPF which will be havinglongest and thickest fiber. It is arranged into five evaluations from A to E, with grade E being the best as it has the longest and thickest strands.

5.1 Morphological Properties of SPF

The evaluation examples broke utilizing a SEM as to help spell out the aftereffects of their rigidity along with modulus of composites that were short. SEM examines the ductile surface of composites that are SPF-HIPS. SEM micrographs of the fracture surfaces of composites in 10 and 20 percent of SPF are looked. It is inclined to be noted in lower fiber loadingsthat the strands sprinkled in way that is non uniform. Strands were confused and also SPF's vast majority filaments agglomeration that is undergone. Additionally, expansion, fiber extract manner has been overwhelming. These manners added at fiber loadings into the high-quality grade of this composites. The highlight of surface in 30 percent of SPF demonstrates fiber haul and that the fiber breakage. At that point surface in 40% of SPF shows the span of activity of these strands.

5.2. Tensile Properties of SPF

Figure 2 displays the tractable modulus of this brief SPF-HIPS compositesin various fiber loadings. The progress from short composites' moduli was found with all the increment of fiber substance. It may be found that the estimation of elastic modulus has been 1706 MPa in fiber chemical of 30 wt%. Nevertheless, the expansion of 40 to half weight of SPF has diminished the modulus that was ductile. For the large part, the diminishingof moduli that are tractable was due of this abatement of bond caliber between the filaments and frame. With this circumstance, for the large part,the decreasing in tractable moduli wasn't exceptionally significant, Figure 2, it's up to now worthy to ensure the expansion of sugar fiber upto half HIPS network extends the stability of their composites. At fiber stuff, it hadbeen hard to acquire marriage of this composites amid production process along these lines diminishing fiber wetting's level. Some variables, for instance, the Type of the fiber as well as the plastic components, the fiber view ratio, fiber material, the process as well as the treatment of this polymeror the strands control the character of carrying [15].

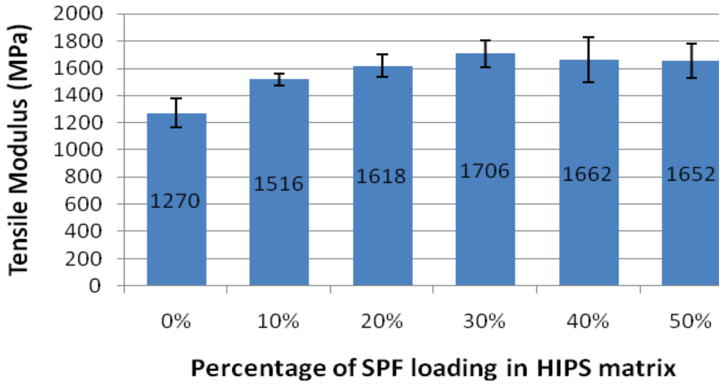


Figure 2. Tensile Modules SPF/HIPS [15]

Ridhwan et al. [16] have examined the effect of (SPF) to the mechanical,physical and thermal properties of sea growth/thermoplastic sugar agar (TPSA) composites. Hybridized seaweed/SPF filler in weight ratio of 25:75,50:50 and 75:25 were inoculated using TPSA because of matrix. Mechanical,physical and thermal properties of half strain composites were also completed. Gotten results Indicated that strain composites show flexural properties and tractable proceeded with obstruction.

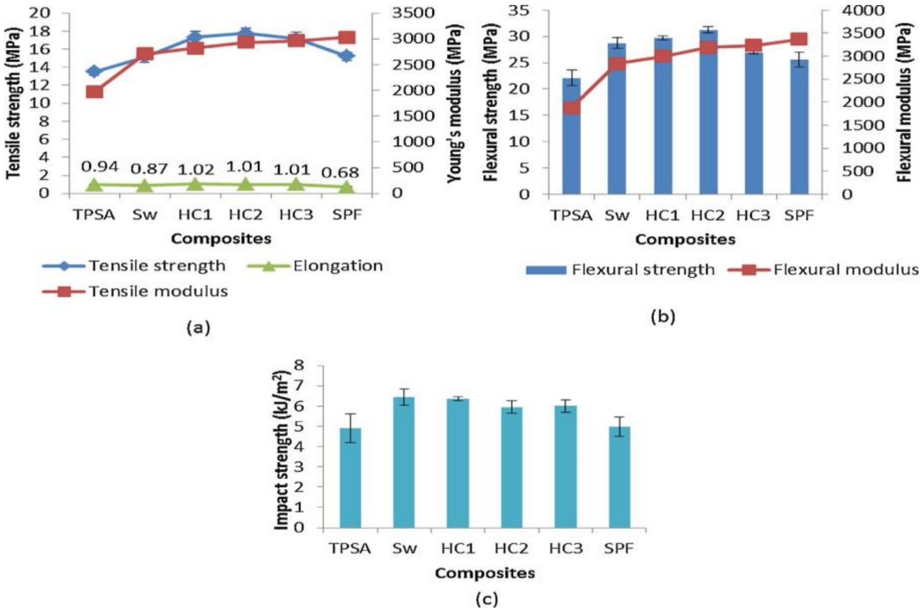


Figure 3. Mechanical Properties of hybridcomposites [16]

The elevated elastic (17.74 MPa) and flexural caliber (31.24 MPa) has beenobtained from hybrid with 50:50 ratio of sea growth/SPF. Great fiber-grid holding has been apparent from the outcome (SEM) micrograph of this crossbreed composites' tensile crack. FTIR examination revealed increment from intermolecular hydrogen carrying subsequent to the expansion of SPF.

5.3. Impact Properties of SPF

Atiqah et al., [17] contemplated the physical and mechanical properties of sugar palm and glass fiber rein-constrained thermoplastic polyurethane half breed composites with the point of examination on the hybrid impacts of the composites made of normal and manufactured strands .The point of this study is to assess the physical properties, for example, thickness, thickness swelling, water absorption though the tractable, flexural and sway properties of sugarpalm, half breed and glass composites were additionally examined. Morphological properties of elastic crack examples of composites were finished by utilizing filtering electron microscopy (SEM). The composites were fabricated at a consistent weight division of absolute fiber stacking at 40 wt.% utilizing melt com-beating strategy. The outcome uncovered that fuse of glass fiber 30 wt.% to sugar palm/TPU composites showed the higher thickness, lower thickness swelling and water absorption properties. The tensile and effect properties of the half and half composites were improved with the expanding of sugar palm fiber content (30/10 SP/G) whencontrasted with glass fiber strengthened composites (0/40 SP/G) because ofthe superb cross breed execution of the two fibers. The flexural properties were expanded when the higher measure of glass fiber was introduced at 40wt.% (0/40 SP/G). The strands splits, fiber haul out and fiber separation of the cracked surfaces are assessed by utilizing filtering electron magnifying lens (SEM) [18]Overall results showed that the consolidation of glass fiber to sugar palm fiber composites can improve the physical and mechanical properties and created half and half composites can be used as a substitute material for glassfiber strengthened polymer composites for different applications.

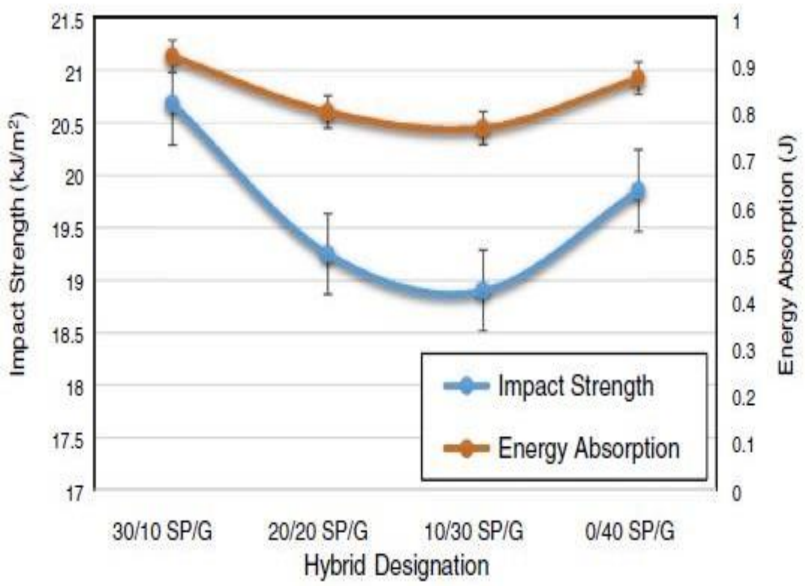


Figure 4. Impact properties of SP/G fiber reinforced TPUhybrid composites [19]

5.4. Thermal Properties of SPF

Thermal solidness of cross strain composites was updated, shown with a greater start degradation fever (259◦C) to get 25:75 kelp/SPFcomposites compared to individual sea expansion com-posits (253◦C). Depth swelling, water consumption, water and dirt entombment tests demonstrated bio-degradation resistance and also water of their half-and- half composites. By and large, SPF with sea growth/TPSA composites' hybridization enhances this biodegradable composite to get application's properties; this can be, plate, expendable plate, etc. The point of this work to explore the impact of glass fiber (GF) on the thermal properties of sugar palm (SP)/ thermoplastic polyurethane (TPU) crossover composites. Sugar palm/glass fiber mixture composites at the extraordinary weight part of 0/40,10/30, 20/20 and 30/10 were set up by utilizing melt-blending exacerbatingpursued by hot squeezing machine. Thermal properties of crossover composites completed by utilizing Dynamic mechanical analyzer (DMA) and thermo-gravimetric analyzer (TGA). The capacity modulus (E′), misfortune modulus (E″) and damping factor (tan δ) were assessed as a component of various relative sugar palm/glass fiber weight portion. Additionally, the pinnacle tallness was researched for tan δ bends [20].

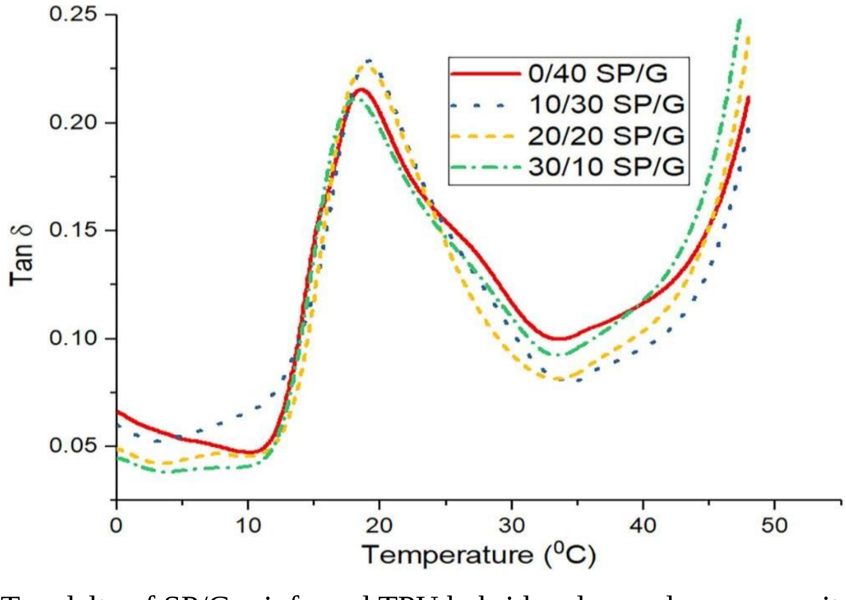


Figure 5. Tan delta of SP/G reinforced TPU hybrid and pureglass composites [20]

At higher glass fiber stacking showed the most astounding stockpiling furthermore, misfortune modulus while the most minimal damping factor was watched for higher sugar palm fiber stacking. Thermogravimetric examination (TGA) showed that the measure of buildupdiminished as the glass fiber stacking diminished. In general, the hybridization of glass fiber with sugar palm/TPU composites improves the thermal properties of the half and half composites for car applications [20].

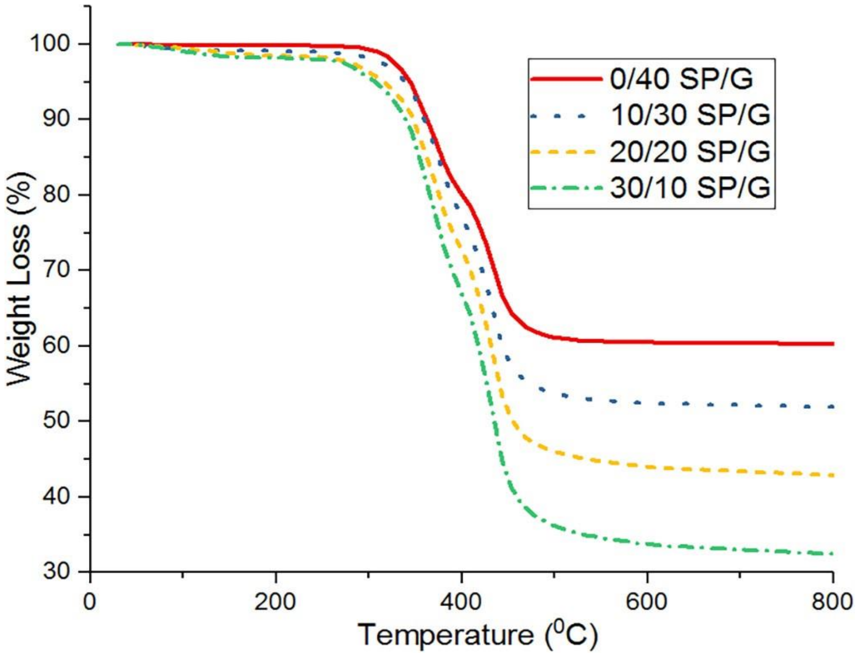


Figure 6. TGA analysis of SP/G reinforced TPU hybrid andpure glass composites [20].

6. Treatment of SPF

Sugar palm fibers can be reinforced with other materials. In this research conducted by F.Agrebi on the dielectric properties of sugar palm fiber (SPF)reinforced phenolic (PF) composites have been considered in the sense of holding among fiber and grid. The paper means to research the impact of antacid treatment and ocean water treatment on SPF composite utilizing thedielectric unwinding spectroscopy in the recurrence go from 0.1 Hz to 0.1 MHz and temperature extend from 80 °C to 200 °C [21].

The outcomes were talked about as far as powerful sub-atomic and interfacial procedure. The investigation proposes that interfacial attachment due to untreated and ocean water treated composites is lesser compare to alkaline treated composite [21]

The effects of microwave treatment on sugar using 6 % NaOH's properties fortified polyurethane composites has been researched. Right offthe bat, then 6 %base arrangement that was soluble treated the sugar strands. At there, microwave treatment has been used to handle the foundation [22] Three kinds oftemperatures filaments and polyurethane gum (such as 70, 80 and also 90^{o}C)were correlated in microwave therapy produce the composites. Hot press machines and even the extruder have been to mixing the SPF [22].

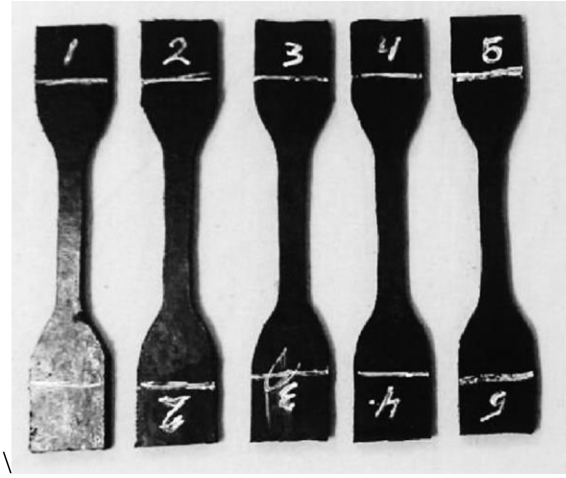
\ 

Figure 7. Tensile specimens [22]

Tensile properties (for example elasticity, ductile modulus and prolongation at break) were considered by following the ASTM D-638 standard. The most astounding elasticity was recorded 18.42 MPa with microwave temperature at 70 °C and 6% antacid pre-treatment. In this way,the temperature 70 °C of microwave treatment may consider the best degreepenny grind [22].

Syafiqah et al. [23] worked on the benzoylation of sugar palm strands (SPF) and its hybridization in glass filaments (GF) fortified epoxy composites through a customary hand lay-up procedure [24].The impact of benzoylation on flexural furthermore, compressive properties at different filaments strands (SPF/GF) proportions,that is, 100:0, 70:30, 50:50, 30:70 and 0:100 of SPF/GF/epoxy cross breed composites were assessed and looked at. The flexural and compressive properties of the composites were researched by ASTM D-790-10 (2010) and ASTM D695-15 (2015) benchmarks [24].

Result investigation uncovered that benzoylation of the SPF impressively improved the flexural and compressive properties of the SPF/GF/epoxy cross breed composites. Anyway the best flexural and compressive properties were watched for treated SPF/GF/epoxy cross breed composites with definition of 30SPF:70GF additionally been supported by the SEM [24]

Ilyas et al. [11] investigates the effect of cycle on their yield, physicochemical, morphological, and thermal behaviour, in addition to the characterization of its reinforced properties. The research was conducted by Nano fibrillated cellulose (NFCs) being removed from sugar palm strands (SPS) in two separate stages; delignification and mercerization to evacuate lignin and hemicellulose, individually. In this way, the acquired cellulose filaments were then precisely extricated into nanofibers utilizing high pressurized homogenization (HPH) [25]. The width dispersion sizes of the confined nanofibers were reliant on the cycle number of HPH treatment.

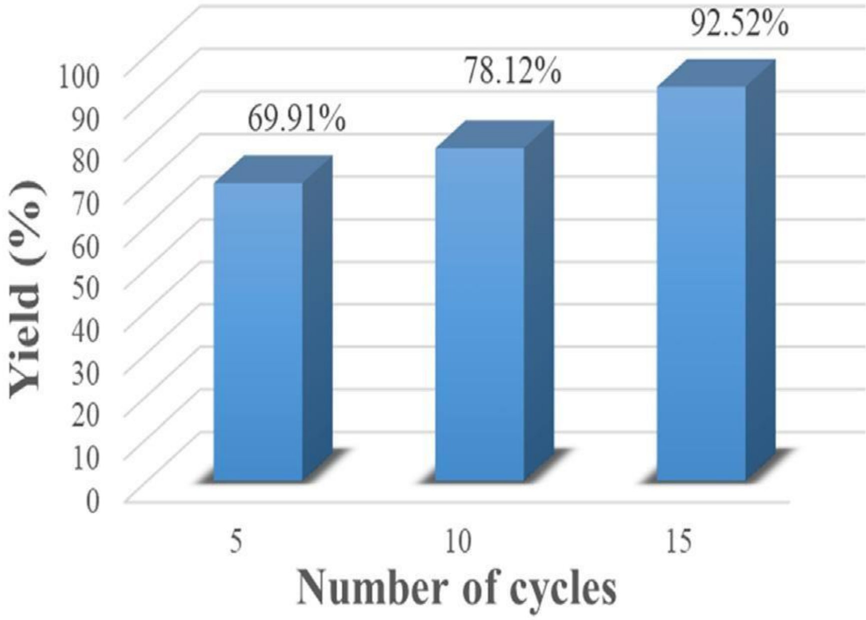


Figure 8. Yields of attained nanofibers after several cycles [25]

TEM smaller scale pictures showed the diminishing pattern of NFCs width, from 21.37 to 5.5 nm when the quantity of cycle HPH was expanded from 5 to 15 cycles, in the meantime TGA and XRD investigation demonstrated that the corruption temperature and crystallinity of the NFCs were marginally expanded from 347 to 347.3 °C and 75.38 to 81.19% separately, when the quantity of cycles expanded. Others investigation additionally were continued such as FT-IR, FESEM, AFM, physical properties, zeta potential and yield investigation. The segregated NFCs might be possibly connected in different application, for example, tissue building frameworks, bio-nanocomposites, filtration media, bio packaging furthermore, and so on [3].

Another test which was conducted thermoplastic polyurethane by melt compounding method using Haake Polydrive R600 internal mixer and followed by hot-pressing moulding [17]. SPF/TPU composites were set up with various fiber stacking: 10%, 20%, 30%, 40% and half (by weight) of SPF, with the idealhandling parameters: 190 °C, 11 min, and 40 rpm for temperature, time andspeed, separately [17]. Ten recreates were cut from the composite sheet as indicated by ASTM gauges.

The thickness, water assimilation and thickness swelling of the compositeswas explored with water submersion time. The thickness of crossover composites increments with expanding of sugar palm fiber [17]. It moreover was discovered that the water assimilation and thicknessswelling increments with fiber substance and water submersion time beforea harmony condition was come to. It was seen that water dissemination happened in composites, contingent upon the fiber content [17].

SPF with 50 % of fiber content display most extreme water retention and thickness swelling amid the entire length of inundation (168h) [26]. In some cases, hybrid methods are used to reinforce base materials which inour case is Sugar palm. In a case conducted by Edhirej et al. [27] on Cassava/sugar palm fiber reinforced cassava starch hybrid composites, a half and half composite was set up from cassava bagasse (CB) and sugar palm fiber (SPF) utilizing casting technique with cassava starch (CS) as network and fructose as a plasticizer [27]. Various loadings of SPF (2,4, 6 and 8% w/w of dry starch) were added to the CS/CB composite film containing 6% CB [27].

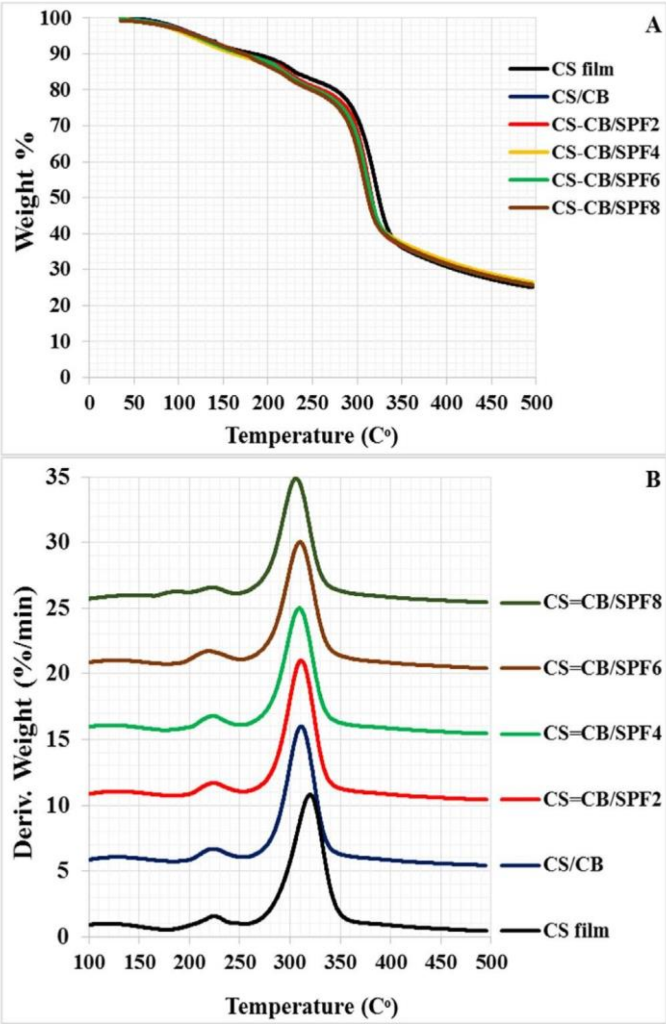


Figure 9. Thermogram (A) TGA curves and (B) DTG curvesof CS film (control), CS/CBcomposite film (0%) and CB/SPF reinforced CS hybrid composites films [27]

The properties were influenced by SPF's expansion. The depth enlarged when decreasing water dissolvability, water information, the density and water consumption. Be as it might, no impact was detected on these combination film’s properties. The crystallinity enlarged up to 47%. SEM micrographs revealed that the filler has been fused from the grid. The film with a greater group of SPF(CS-CB/SPF8) revealed anever more heterogeneous surface. Maybe it is assumed the linking of SPF prompted fluctuations in cassava starch movie possessions [27].

Rashid et al., [28] the potential upgrades in the wear obstruction of phenolic network composites from utilizing sugar palm fiber (SPF) as a support. Consequently, open another methodology for using the accessible locally shoddy and non-lethal bras to create a forthcoming competitor tribo-materials for grinding application, for example, brake cushion composites. The fibers were treatedwith seawater for 30 days and with a 0.5% soluble answer for improve the fiber-grid attachment [28]. From that point, the fibers were utilized in molecule structure with a volume stacking of 30% to create the examples utilizing a hot press machine. The tribology-properties of the created composites were tried utilizing an automated stick on circle machine.Different mixes of various parameters test were conducted, for example, type of treatment, applied normal load (30,50, and70N), and sliding speed (2.6,3.9, and5.2m/s) at a steady sliding separation of 5000 m under dry sliding conditions [28]. Factorial system, alongside ANOVA investigation, were utilized to recognize the significant and significant plan factors. The outcomes portray that the volume loss of the seawater and soluble base treated composites diminished by about 20.2% and 37.9%, individually, though the coefficient of grating decreased by 10% and 13%, separately, contrasted with the untreated composite. In addition, ANOVA investigation uncovered that the connected ordinary burden and treatment made the most significant commitment to the volume, while the sliding pace had no significant impact on the wear results. Worn surface morphology examination was completed to help the outcomes [28].

7. Sustainable development with Sugar Palm

Quick weariness of oil assets combined with expanding consciousness of worldwide ecological issues identified with the utilization of customary plastics are the principle main thrusts for the far-reaching acknowledgmentof normal fibers and biopolymers as green products [29]. Characteristic fibers and biopolymers havepulled in extensive consideration of researcher and businesses because of their ecologically well-disposed and properties of eco-friendly [30].

The extraordinary mechanical properties of SPF are due to the cellulose (66.49%). Various method can be used to upgrade the properties of starch that are extracted from the SP tress. From writing survey, obviously no far reaching audit paper distributed on SPF, SPS, and its bio composites. Present audit centers around late works identified with properties of SPF and SPS, and their manufacture as green composites.The capability of SPF for this modern age is also revealed by a survey conducted [31].

8. Conclusions

The review concludes that sugar palm lignocellulosic fibre reinforced polymer composites have considerably expanded their reach in industrial applications. After alkaline treatment of SPF, hybridization with glass fibre, and incorporation with various polymer matrices, it exhibits good mechanical and thermal properties. In summary, the use of sugar palm lignocellulosic fibre reinforced polymer composite can support with the future development of sugar palm as a new industrial crop, the reduction of reliance on petroleum products, and the reduction of the negative impact on the environment of synthetic polymers and fibres. However, there is still much work to be done on these composites, such as lowering manufacturing costs, increasing availability, and opening new markets such as motorcycle body framing, toys, household items, pharmaceutical, and electronic packaging to make hybrid composites more common in replacing petroleum-based plastic.

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