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A Review on Properties, Applications and Feasibility Study of Date Palm Fiber-Reinforced Polymer Composites

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Abstract Recently Polymer/natural fiber composites have earning major consideration due to the big development in non-renewable materials. Many studies were carried out to obtain new composite materials. This review will give significant information about polymer composite materials reinforced with natural fiber especially date palm fiber (DPF). Different machining processes can be applied to the polymer/DPF composite materials conventional or non-conventional machining process. Conventional machining processes like drilling, milling and grinding can be used to create the final shape of polymer/DPF composites. Non-conventional machining processes such as laser beams and water jets are very useful processes when they are used to modify the shape and size of the polymer/DPF composites. Developing the machinability of the natural fiber/polymer composites increased the ability to use these composites in several engineering applications. Moreover, this review illustrates the potential applications of polymer/date palm fiber (DPF) composites because DPF is eco-friendly, lightweight, obtainable in nature, has good sound and thermal insulation and is not expensive material. The applications of polymer/DPF composites include fabrication of the tunnels for air conditioning applications, using polymer/DPF composites in building applications, manufacturing automotive parts like dashboard panels, and using them in the fabrication of the home furniture industry.

Keywords: Natural fiber; Date palm fiber; polymer composites; feasibility study.

1 Introduction

For the time being, composites are considered a substantial material used in different engineering applications due to their singular properties like good strength, lightweight, not being expensive and including advantages of the fillers and neat matrix materials [1-6]. When the composite materials are produced there are many odds for reinforcement can be used such as synthetic fibers, natural fibers, hybrid of synthetic/synthetic fibers, hybrid of natural/natural fibers and hybrid of synthetic/ natural fibers.

The redundant deviations of several composites are shown in **Fig.1**. From all last mentioned reinforcements, natural fibers (NFs) are considered the usually desired type in the composite materials because natural fibers are considered eco-friendly materials [7-11]. Natural fibers (NFs) are assured to be better than man-made fibers for developing new materials used in various sectors like energy conservation applications and low-load applications [12-17].

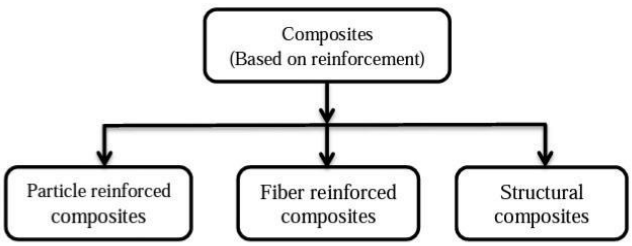

Fig. 1 composites types according to kind of reinforcement [18].

Several fibers are used to reinforce the polymer matrices to enhance the characteristics of the produced composites. The fibers can enhance mechanical properties like tensile strength, tensile modulus, flexural strength, flexural modulus, hardness and impact strength. Moreover, fibers can enhance physical properties such as water absorption, thickness swelling, and density. Thermal insulation, sound insulation and several special properties can be improved by reinforcing polymers with fibers. Many kinds of fibers are considered not expensive materials especially natural fibers so using these fibers to reinforce polymer composites are very good choice [19].

The fibers used to reinforce polymer composites may

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be natural fiber or synthetic fiber. Synthetic fiber which called man-made fiber like glass fiber and carbon fiber. Many researchers preferred to decrease using man-made fibers because they are hazardous to the environment. Natural fibers which include plant fibers and animal fibers have been widely used recently to reinforce polymer composites because they are not expensive materials, lightweight and eco-friendly materials [20-23].

These fibers and particulates, greatly numbers of them are inorganics, are utilized to reinforce polymer matrices to improve the composite properties mechanical, chemical, physical and economic properties [24]. Using raw natural fibers to reinforce polymer composites faces many problems such as low bonding and weak adhesion between fibers and polymer matrices. So the solution for these problems is using treatments to improve the natural fiber surface to increase the adhesion between natural fibers and polymer matrices. The most famous method used to enhance the natural fiber surface is the chemical method, especially using NaOH with low concentrations of about 5 %. This method can clean the fiber surface and remove the particles and impurities, which positively affect the adhesion and bonding forces between natural fiber and polymer matrices. Enhancing the adhesion between the natural fiber and polymer matrices will increase the good mechanical and physical characteristics of the composites [25].

Date palm trees (DPTs) are plentiful in the Arab zone, with about 67 % of the DPTs in the world present in Arab countries. The date palm, coconut and oil palm are the most substantial trees in the palm family [26]. Within plowing and collecting of the fruits, trees of date palms decrease various residues, like fronds, leaf sheath, and leaflet. The massive wastes from the DPTs may cause environmental pollution [27]. These wastes can be utilized to manufacture not expensive and eco-friendly composite materials [28]. Also, these wastes can be scope reinforcements for many polymers used in lightweight applications.

The objective of this work is to study the feasibility of date palm fiber-reinforced polymer composites in various industrial applications. Because DPF-reinforced composite is counted as a very significant material and can be used in various engineering applications like building sound and thermal insulations, automotive parts, home furniture and sports equipment's. Moreover, polymer/date palm fiber composites are considered lightweight, eco-friendly and not expensive materials.

2 Investigation the feasibility for using the polymer/natural fiber composite for different applications

Owing to increasing environment troubles the researchers wanted to promote biodegradable [29, 30], recyclable [31], and eco-friendly composite materials [32]. Natural fibers (NFs) such as ramie, date palm, kenaf, jute, flax, hemp and sisal have the seniority to utilize more than carbon and glass fibers to reinforce the polymer matrices owing to their good characteristics [33-38]. These fibers have great characteristics like strength [39, 40], flexibility, toughness, and stiffness [41-45]. Furthermore, they are obtainable [46], also they are renewable and continuous [47].

To replace the primary raw materials into the final shape without finding any defects in the manufactured part, the manufacturer try to use an adequate manufacturing method. The polymer/DPF composites have many applications due to the easy fabrication method that can used to produce the polymer/DPF composites. Also, the date palm fiber is very compatible with several polymer matrices such as UPVC, epoxy, polyester and polypropylene. The low-cost of DPF helped the manufacturer to develop new polymer composites using it [48].

The most famous techniques that can be used to fabricate polymer/DPF composites are injection molding technique, compression molding technique and hand lay-up technique. The easy using of these techniques helped the manufacturer to develop a huge number of polymer/natural fiber composites that serve different engineering applications [49].

Many researchers interested recently with developing composite materials, especially polymer/Natural fiber composites. Polymer/DPF composites can be used in several applications due to the ability of date palm fiber to reinforce different polymer matrices. For example when date palm fiber is used to reinforce the UPVC matrix, the resultant composites can be widely used in the building sector. New buildings used UPVC/natural fiber to fabricate window and door frames owing to the ability of this kind of composites to insulate heat, sound and moisture better than metal frames. Moreover, epoxy/DPF composites have good mechanical, thermal, acoustic and physical properties. Epoxy/DPF can be used in buildings to fabricate the insulating boards in roofs and walls [50].

3 Advantages and Disadvantages of polymer/natural fiber composites

Furthermore, superior thermal and mechanical properties, polymer/natural fiber composites have many advantages over ordinary materials according to **Table. 1**. These advantages are gradually being utilized in the building sector for infrastructure applications.

Table. 1 Merit Comparison and between FRP and Steel [51].

Property (Parameter)	FRP	Steel
Strength/stiffness	High	High
Weight	Very High	Low
Corrosion resistance	Very High	Medium
Ease of field construction	Very High	Medium
Ease of repair	Very High	High
Fire	Medium	Low
Transportation	Very High	Medium
Toughness	High	High
Acceptance	Medium	Very High
Maintenance	Very High	Medium

Note: A higher rating indicates better desirability of the property.

Some of the marine applications like gates of miter will strongly benefit by utilizing of polymer/NFs composites according to high strength, high stiffness, corrosion resistance and good durability, moreover considered low-cost materials. Some of the features of polymer/NF composites are lightweight, rapid installation, reduced interruption, excellent durability, fatigue resistance, impact resistance and cost savings [51].

4 Machinability of polymer/natural fiber composites

Manufacturers were carried out to achieve new polymer composite materials reinforced with natural fibers. The ability to use several machining processes in polymer/NF composites played an important role in developing these kinds of new composites. One of the most famous examples of natural fibers is the date palm fiber. Several machining processes can be used in the polymer/DPF composite materials conventional or non-conventional machining types in the workshop. Conventional machining processes such as drilling, milling and grinding can be used to fabricate the final shape of polymer/DPF composites. Non-conventional machining processes like laser beams and water jets are very significant processes when they used to enhance the final shape and size of the polymer/DPF composites. Developing the machinability of the natural fiber/polymer composites improved the ability to use these composites in several industrial applications [52, 53]. Several affronts come through over-machining of the polymer/NF composites relative to the conventional materials. The workshop tools of machines can be used to fabricate and finish the parts fabricated from polymer/natural fiber composites [54].

As shown in **Fig. 2** indicates the machining process types which mainly divided into two main categories conventional machining process and non-conventional machining process. The conventional process includes drilling, milling, grinding and turning. The non-conventional machining process includes waterjet, ultrasonic and laser beam. Both conventional and non-conventional machining processes can be used to fabricate and finish the surface of the parts manufactured from polymer/DPF composites. The machinability of polymer/DPF composites helped in developing these types of composites for use in many engineering applications [55].

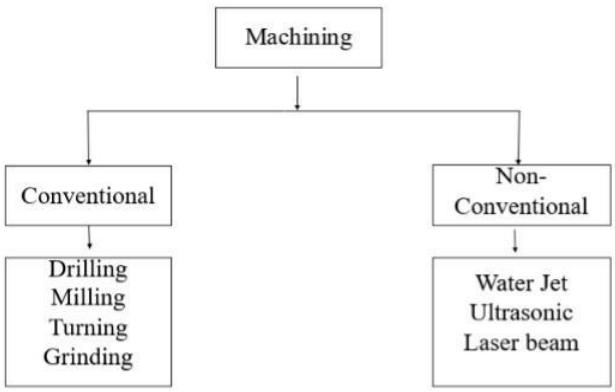

Fig. 2. Machining process types for various materials [56].

5 Potential Applications of using polymer/ DPF composites

The date palm tree is one of the most ancient and famous trees grow in hot zones, especially in Arab countries such as Egypt, Iraq and Saudi Arabia. Date palm trees produce huge amounts of fiber waste like leaf sheath, leaf let and trunk of the tree. In many regions, the waste fiber of date palm trees are burned which pollutes the environment. Many researchers try to use date palm fiber to reinforce polymer composites and produce several types

of composites can be used in different industrial applications [57].

As illustrated in [58], the KSA produces about 200,000 tons of date palm biomass/year. Moreover, the obtainability of the DPs in Arab zones with massive amounts, date palms have the feature of being considered a renewable material as they can be substituted in a short time [59]. Commonly, wastes of the date palm are burned in nature, which causes pollution for the environment [60-62].

Researchers want to solve the design problems especially material selections, so they think to use natural fibers to reinforce polymer composites to benefit from their advantages. Using natural fibers to reinforce polymer matrix composites can solve many problems such as low strength, low impact strength and decreasing mechanical and physical properties [63].

Using composite materials can solve the problems found in single polymer matrices [64]. Using simple manufacturing techniques such as injection molding compression molding and hand lay-up helped the designers and manufacturers to develop and use new polymer/date palm fiber composites in several engineering applications [65].

5.1 Production of date palm fiber

The production rate of some natural fibers has been illustrating in **Fig. 3** [29, 66]. The date palm has advanced ranking among natural fibers as illustrated in [67]. Considering the high production of date palm fibers, these make can be used in polymer reinforcement to produce new composites used in several applications such as car parts and the building sector.

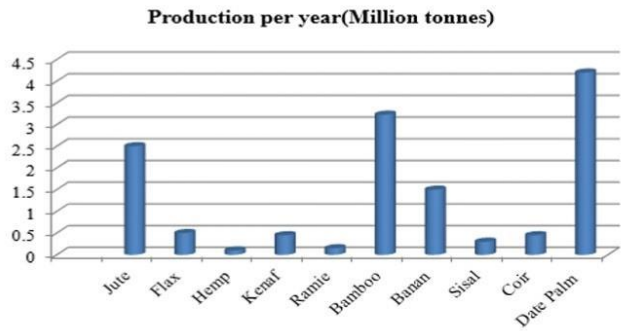

Fig. 3. Approximate amount of the produced natural fibers in the world [69].

Date palm is considered a renewable fiber, whose output can occur in the short-run [59]. It is known that the Arabic zone produces about 66 % of the world's date palm (**Fig. 4**) [29]. An average of 20 kg of residues can be produced by a DPT every year. These huge amounts of date palm fiber can be used to produce huge amounts of polymer/DPF composites [62, 68]. So, it is suggested to use such residues in manufacturing the polymer/ date palm fiber composites to prevent environmental pollution.

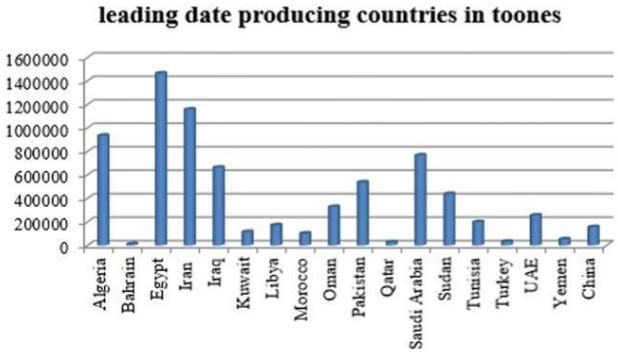

Fig. 4. Countries with high date-production [69].

5.2 Using DPF to reinforce polymer composites

Table. 2 illustrates new research used different parts of the date palm trees to reinforce different polymer matrices. The most famous polymer matrices used are polyester, epoxy LDPE and polypropylene due to their huge engineering applications in many sectors and good properties. Moreover, using simple manufacturing methods like injection molding compression molding and hand lay-up helped the researchers and manufacturers to produce and use new polymer/date palm fiber composites in several engineering applications. Using chemical treating methods for date palm fiber helped in enhancing the fiber properties and improved the bondability with different polymer matrices. Also, some natural fibers can added to date palm fiber in the single polymer matrix to produce hybrid composites. Hybrid composites have good mechanical, physical and chemical properties [70].

Table. 2. Various polymer/DPF composites.

Reinforcements	Polymers	References
DPF	Polyester	[71]
DPLF	Epoxy	[72]
DPF	Polyethylene	[73]
Bleached DPF	LDPE	[74]
Bleached DPF	PP	[74]
DPF/coconut cell particulate	Epoxy	[75]

Note: Low-density polyethylene-(LDPE); Polypropylene-(PP).

5.3 Hybrid Composites using DPF as a reinforcement fillers

The hybrids of polymer composites are blending of more than one fiber in a single polymer matrix and may divided into natural/natural, synthetic/synthetic, or natural/synthetic fibers; these composites have good strength, low density, and low-cost. In addition, they can be fabricated easily and have different engineering applications [76]. Moreover, hybrid polymer composites have good mechanical and physical properties making them used in different engineering applications [77].

Many NF can be added to DPF in the same polymer matrix to improve the proprieties of produced hybrid polymer composites. Mohamad Reda A. Refaai et al. [78] investigated the characteristics of epoxy/date palm fiber/bamboo hybrid composites. Syed Waheedullah Ghori, and G. Srinivasa Rao [79] studied the influence of fiber content of DPF and Kenaf fiber-reinforced epoxy composites. Mohammed Y Abdellah et al [80] studied the properties of DPF/sheep wool hybrid reinforced polyester matrix. They evaluated the mechanical, sound insulation, and thermal characteristics of date palm fiber (DPF)/polyester composite and polyester/date palm fiber/sheep wool hybrid. A.B.M. Supian et al. [81] investigated the properties of epoxy/date palm fiber/bamboo fiber composites. They investigated the properties of different parts of DPT (leaf sheath and stem) to reinforce epoxy composites.

6 Evaluation the feasibility of using polymer/DPF composites in different engineering applications

Polymer/NF composites have different applications in various sectors like infrastructure, sports equipment, household applications, furniture, consumer goods, and automotive [82-84]. In addition, there are various recent applications of these composites e.g., photovoltaic, optic, and electrical, which are being discovered [85-87]. The most significant purpose of using NF are cost and environmental saving [88-94].

6.1 Using polymer/DPF composites in fabrication tunnels for air conditioning application

Polymer/DPF composites and DPF/sheep wool hybrid reinforced polymer composites are considered good insulation composite materials so they can be used in producing tunnels of air conditioning applications because they can insulate heating and acoustic well, also they are considered an eco-friendly composite materials, lightweight, good strength and low cost. The polymer/NF composites can utilized as stand-by materials for metal duct tunnels which insulate with glass wools in air conditioning applications. **Table. 3** shows a comparison between polyester/DPF-sheep wool hybrid and metal duct insulation with glass wool used in tunnel fabrication in air conditioning applications.

Table.3 comparison between polyester/DPF-sheep wool hybrid and metal duct insulate with glass wool [80, 95, 96].

Property	Polyester/DPF-sheep wool duct	Metal duct
Thermal cond., W/m.k	0.051	0.0343
Sound.T. loss, dB	24	20
Cost, EG.P/1 m^2	900	1200
Environmental effect	Eco-friendly	Not friendly
Production	Simple fabrication	More complex
Mechanical properties	High strength material	Low strength
Density	Low density	Low density

Many researchers indicate the potentiality of using both polymer/DPF composites and DPF/natural fiber hybrid to reinforce polymer composites in sound and heat insulation applications. Israa F Ghazi and Riyam I Jaddan [97] fabricated polymer/DPF and indicated that they have good thermal insulation properties.

Fig.5 indicates a lowering in the thermal conductivity of epoxy/DPF composite owing to reinforcing epoxy with date palm fiber.

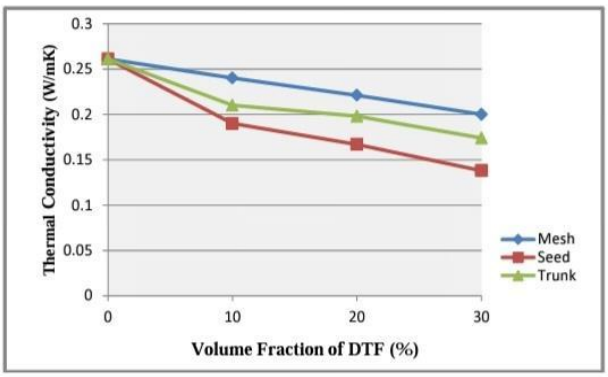

Fig.5. DPF/ epoxy composite thermal conductivity with the fiber content [97].

M. Mohammad et al. [98] researched to determine the acoustic absorption coefficient (α) and noise reduction coefficient (NCR) of date palm fiber.

The samples manufactured by DPF have been compressed using a certain weight to keep the desired thickness ranging from ten mm to fifty mm. The matrix has been mixed with coconut fiber at a certain ratio. An experiment was conducted using an impedance tube to evaluate the acoustic absorption coefficient values following ISO 10534-2:1998 standard procedure. The experimental results showed that the samples having high thickness have high values of α and NCR. As shown in [80] the date palm fiber improved the acoustic insulation behaviors of the polyester/DPF composite with weight fractions of 10%, 20%, and 30%. **Fig.6** shows the thermal conductivity of polyester/date palm fiber (DPF) composites and polyester/DPF and sheep wool hybrids.

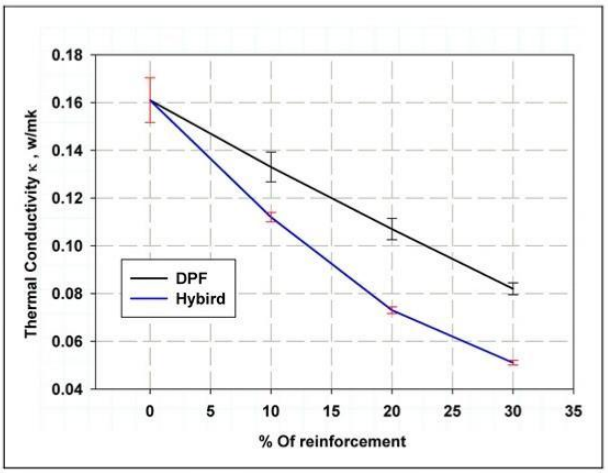

Fig .6. Thermal conductivity of polyester/date palm fiber (DPF) composites and polyester/DPF and sheep wool hybrids [80].

6.2 Using polymer/DPF composites in construction application

The use of polymer/NF natural fiber composites is increasing rapidly to achieve recent global needs from not expensive constructions [99]. Lumen/Voids found in in the natural fibers support these composites to have better acoustic and thermal insulation behaviors, particularly in building homes [100]. Some parts in structural sector like panels and beams were produced from polymer/NF composites [101].

Saravana and Mohan [102] proved that natural fiber-reinforced polymer composites are very useful in producing building materials. Many researchers proved that NFs are a good choice for building and construction applications. Swamy et al.[103] using NFs and mixing with polymer to fabricate new composites and they found that they have a-good sound insulation properties and they are helpful for structural and new design home applications due to the ability of natural fibers to insulate sound well. Many types of natural fibers like the date palm fiber, sheep wool fiber and Jute fiber-reinforced polymer composites are used in structural and building applications such as manufacturing some parts in ceiling, window and door frames, floor and wall partitions, mobile or manufactured buildings and panels for partition etc. [104]. Li and Matuana [105] used polymer/DPF composites to produce some kinds of window frames.

Maheswari et al. [106] mixed natural fiber with high-density polyethylene (HDPE) to manufacture-high performance composites for a-good packaging material and in different secondary structural applications. In addition to some studies have evaluated polypropylene/NF composites for structural and manufacturing feasibility for insulated panelized construction, used as skin in the panels [107]. In addition, many researchers have fabricated cellular beams and plates with polyester/NF composites as load-bearing structural parts, wherein it was indicated that NFPCs can be used as load-bearing components with some enhancement in their performance as structural parts by arranging the cellular material [108]. Ramnath et al. [109] illustrated that polymer/NF composites are convenient for the housing and packaging industry. Ghavami [110] has illustrated the use of natural fibers to fabricate structural parts. Green composites have found different applications in building materials such as doors, bridges, fencing etc. [111]. Several types of NFs that are used to reinforce polymer composites and can be used in structure sector applications are date palm fiber, jute fiber [112], coir fiber [113], flax fiber [114], corn stalk [115] and hemp fiber [116].

6.3 Using polymer/DPF composites in automotive application

Many researchers indicated that regarding precise decisions for selecting adequate NF composites for a particular application [42, 117]. Sapuan et al. [117] have used the Analytical Hierarchy Process (AHP) method to indicate the adequate natural fiber composite materials for car dashboard panels, where a database of characteristics for natural fiber composite materials was systematically organized.

The behaviors of materials considered in that study were only the density, the modulus of elasticity and the tensile strength. They considered 29 kinds of natural fiber

composite materials to rank their possibility for use in manufacturing the automotive dashboard panel.

With the world's requirements in the automotive sector towards low-cost, lightweight materials and eco-friendly materials, the use of natural fibers is increasingly achieving importance. Moreover, the date palm fiber can reinforce many types of polymer matrices such as UPVC, epoxy, polyester and polypropylene. The low-cost and good properties of date palm fibers helped the manufacturer and designer to manufacture new polymer composites using it. These composites are used widely in car parts fabrication. New cars need to be lightweight and high speed so designers prefer to use polymer/DPF composites to fabricate many car parts from these composites. The good mechanical, physical, and chemical properties of polymer/natural fiber composites encouraged the manufacturer to use them in car parts fabrication. Moreover, polymer/natural fiber composites have good thermal and acoustic insulation properties so they can be used to fabricate some internal automotive parts [118].

Recently, NFPCs have been widely used in manufacturing automotive parts in the Europe zone. Using natural fibers in manufacturing automotive parts has given more importance to research in the field of NFPCs. Natural fiber composites such as polyester/DPF and Polypropylene/DPF composites can be used to manufacture various parts for automobiles is already in vogue in German automotive industries [119].

6.4 Using polymer/DPF composites in fabrication the home furniture application

Natural fiber is a category of renewable source and a new descent of supplements for polymer-based materials The future possibility of natural reservoirs and solving the environmental problem have forced us to use natural fiber materials for the growth of polymer composites [120]. Recently, using natural fibers reinforced polymer composites from both nonrenewable (petroleum-based) and renewable resources used to manufacture polymer composites that are competitive with synthetic composites are achieving much more attention [121] Natural fibers are significant materials relative to synthetic fibers owing to their features, I e, lightweight, less damage to processing equipment, the enhanced surface finish of molded parts composite, high mechanical characteristics, and are considered available material in nature [122]. High-specific behaviors with low cost of natural fibers are making it fascinating for different applications in several sectors like home furniture, packing, building sector and car parts [32].

Low-density PE (LDPE) reinforced with natural fibers like DPF is another PE-based composite, which has enhanced mechanical characteristics and is possible for use in furniture industries applications [123] Fibrous-shaped fine wood powder was produced by grinding large pieces of date palm wood and then used as filler in LDPE matrix after blending both components, the final composite was fabricated by compression molding technique. The mechanical characteristics (static and dynamic), water uptake, and adhesive behaviors of the manufactured composites were also evaluated. The influence of filler content ranged from 10 to 70 wt. % on composite characteristics was also investigated. The results illustrated that the hardness and stiffness of the composites calculated from modulus of elasticity were greatly improved with an increase in the filler loading in the entire range of concentration, the best result was 1,933MPa for the composite reinforced with 70 wt. % of the filler. The flexural strength of the composite was also enhanced by the existence of the filler with a maximum value of 17.8 MPa for the composite filled with 70 wt. % of the filler. However, there was an increasing tendency to uptake water by the composite with increasing fiber loading detected by the water uptake test. The polarity of the composite was also enhanced by the addition of DPW to the LDPE matrix, which was a result of better bonding between fiber and matrix. All these results showed that this composite can be used to manufacture different kinds of furniture [124]. Due to the importance of polymer composite applications many studies carried out about these composites [125-127].

7 Conclusions

The focus of the recent world is on the improvement of composite materials that are lightweight and eco-friendly. Natural fibers have become a general topic for discussion related to the standing by of their synthetic fibers. This is owing to the ability of natural fibers to decrease the weight of the composite material and their effective mechanical, physical and thermal characteristics, as well as their feasible economic features. This work discussed the potential of using date palm fibers reinforced polymer composites in different applications instead of the old materials. The essential purpose of using date palm fiber to reinforce polymer composites is saving money and save environment so they can be used to manufacture tunnels for air conditioning applications.

Date palm fiber-reinforced polymer composites can be used in construction applications due to their good mechanical, physical and thermal properties. Famous examples of using polymer/DPF composites in construction application like ceiling, window panels, floor and wall partitions, mobile or manufactured buildings and panels for partition etc. Moreover, date palm fiber-reinforced polymer composites can be used to fabricate some automotive parts. In addition to, date palm fiber-reinforced polymer composites can be used to manufacture various parts of home furniture.

References

[1] P. Jagadeesh, M. Puttegowda, P. Boonyasopon, S. M. Rangappa, A. Khan, and S. Siengchin, "Recent developments and challenges in natural fiber composites: A review," *Polymer Composites*, vol. 43, pp. 2545-2561, 2022.

[2] A. Mohanty, M. a. Misra, and G. Hinrichsen, "Biofibres, biodegradable polymers and biocomposites: An overview," *Macromolecular materials and Engineering*, vol. 276, pp. 1-24, 2000.

[3] M. K. Singh and S. Zafar, "Development and mechanical characterization of microwave-cured thermoplastic based natural fibre reinforced composites," *Journal of Thermoplastic Composite Materials*, vol. 32, pp. 1427-1442, 2019.

[4] D. V. Srinivasan and S. Idapalapati, "Review of debonding techniques in adhesively bonded composite structures for sustainability," *Sustainable Materials and Technologies*, vol. 30, p. e00345, 2021.

[5] S. Khamtree, T. Ratanawilai, and S. Ratanawilai, "Determining the optimum conditions for silane treated rubberwood flour-recycled polypropylene composites using response surface methodology," *Materials Today Communications*, vol. 24, p. 100971, 2020.

[6] M. S. Islam, N. A. B. Hasbullah, M. Hasan, Z. A. Talib, M. Jawaid, and M. M. Haafiz, "Physical, mechanical and biodegradable properties of kenaf/coir hybrid fiber reinforced polymer nanocomposites," *Materials Today Communications*, vol. 4, pp. 69-76, 2015.

[7] I. De Rosa, A. Iannoni, J. Kenny, D. Puglia, C. Santulli, F. Sarasini, *et al.*, "Poly (lactic acid)/Phormium tenax composites: Morphology and thermo-mechanical behavior," *Polymer Composites*, vol. 32, pp. 1362-1368, 2011.

[8] P. Jagadeesh, M. Puttegowda, O. P. Oladijo, C. W. Lai, S. Gorbatyuk, D. Matykiewicz, *et al.*, "A comprehensive review on polymer composites in railway applications," *Polymer Composites*, vol. 43, pp. 1238-1251, 2022.

[9] T. Sathish, P. Jagadeesh, S. M. Rangappa, and S. Siengchin, "Studies on mechanical and thermal properties of cellulosic fiber fillers reinforced epoxy composites," *Polymer Composites*, vol. 43, pp. 4297-4305, 2022.

[10] M. H. Ameer, Y. Nawab, Z. Ali, A. Imad, and S. Ahmad, "Development and characterization of jute/polypropylene composite by using comingled nonwoven structures," *The Journal of The Textile Institute*, 2019.

[11] M. H. Ameer, K. Shaker, M. Ashraf, M. Karahan, Y. Nawab, S. Ahmad, *et al.*, "Interdependence of moisture, mechanical properties, and hydrophobic treatment of jute fibre-reinforced composite materials," *The Journal of the Textile Institute*, vol. 108, pp. 1768-1776, 2017.

[12] H. Pulikkalparambil, D. Nandi, S. M. Rangappa, S. Prasanth, and S. Siengchin, "Polymer composites from natural fibers and recycled waste surgical masks during COVID-19 pandemic," *Polymer Composites*, vol. 43, pp. 3944-3950, 2022.

[13] S. M. Rangappa, S. Siengchin, J. Parameswaranpillai, M. Jawaid, and T. Ozbakkaloglu, "Lignocellulosic fiber reinforced composites: Progress, performance, properties, applications, and future perspectives," *Polymer Composites*, vol. 43, pp. 645-691, 2022.

[14] G. Rajeshkumar, S. A. Seshadri, S. Ramakrishnan, M. Sanjay, S. Siengchin, and K. Nagaraja, "A comprehensive review on natural fiber/nano-clay reinforced hybrid polymeric composites: Materials and technologies," *Polymer Composites*, vol. 42, pp. 3687-3701, 2021.

[15] M. Marichelvam, P. Manimaran, A. Verma, M. Sanjay, S. Siengchin, K. Kandakodeeswaran, *et al.*, "A novel palm sheath and sugarcane bagasse fiber based hybrid composites for automotive applications: An experimental approach," *Polymer Composites*, vol. 42, pp. 512-521, 2021.

[16] H. Awais, Y. Nawab, A. Amjad, A. Anjang, H. M. Akil, and M. S. Z. Abidin, "Environmental benign natural fibre reinforced thermoplastic composites: A review," *Composites Part C: Open Access*, vol. 4, p. 100082, 2021.

[17] H. Awais, Y. Nawab, A. Anjang, H. M. Akil, and M. S. Z. Abidin, "Mechanical properties of continuous natural fibres (jute, hemp, flax) reinforced polypropylene composites modified with hollow glass microspheres," *Fibers and Polymers*, vol. 21, pp. 2076-2083, 2020.

[18] Z. Huda and Z. Huda, "Mechanical Behavior of Composite Materials," *Mechanical Behavior of Materials: Fundamentals, Analysis, and Calculations*, pp. 267-281, 2022.

[19] H. A Hamde, "Mechanical Properties of Low Density Polyethylene/Citrus Aurantium Shell Composite," *Journal of Education and Science*, vol. 26, pp. 32-39, 2013.

[20] F. Chalkiopoulou, I. Chatzipanagis, K. Valta, and C. Christidis, "Production of high value added carbonate fillers from the treatment of white calcitic marble waste: the case of Eastern Macedonia and Thrace of Greece," in *Proceedings of the 3rd International Conference on Sustainable Solid Waste Management, Tinos Island, Greece*, 2015, pp. 2-4.

[21] M. Xanthos, *Functional fillers for plastics*: John Wiley & Sons, 2010.

[22] I. Čatić, "Herman F. Mark: Encyclopedia of Polymer Science and Technology, concise," *Polimeri: časopis za plastiku i gumu*, vol. 28, pp. 288-288, 2007.

[23] T. Syed, A. S. Thelakkadan, and S. Al-Hussain, "Date-Palm Fiber as a Reinforcement Filler in Polymer Composites," *Advances in Sciences and Engineering*, vol. 12, pp. 78-85, 2020.

[24] D. V. Rosato, "Rosato's Plastics Encyclopedia and Dictionary," *(No Title)*, 1993.

[25] S. Vogel, *Cats' paws and catapults*: Penguin Books, 1998.

[26] M. D. Alotaibi, B. A. Alshammari, N. Saba, O. Y. Alothman, M. Sanjay, Z. Almutairi, *et al.*, "Characterization of natural fiber obtained from different parts of date palm tree (Phoenix dactylifera L.)," *International journal of biological macromolecules*, vol. 135, pp. 69-76, 2019.

[27] N. Saba, O. Y. Alothman, Z. Almutairi, M. Jawaid, and W. Ghori, "Date palm reinforced epoxy composites: tensile, impact and morphological properties," *Journal of Materials Research and Technology*, vol. 8, pp. 3959-3969, 2019.

[28] F. A. Al-Sulaiman, "Mechanical properties of date palm fiber reinforced composites," *Applied Composite Materials*, vol. 9, p. 369, 2002.

[29] F. M. Al-Oqla and S. Sapuan, "Natural fiber reinforced polymer composites in industrial applications: feasibility of date palm fibers for sustainable automotive industry," *Journal of Cleaner Production*, vol. 66, pp. 347-354, 2014.

[30] K. Ashwini and C. M. Rao, "Design and analysis of leaf spring using various composites–an overview," *Materials Today: Proceedings*, vol. 5, pp. 5716-5721, 2018.

[31] G. Koronis, A. Silva, and M. Fontul, "Green composites: A review of adequate materials for automotive applications," *Composites Part B: Engineering*, vol. 44, pp. 120-127, 2013.

[32] M.-p. Ho, H. Wang, J.-H. Lee, C.-k. Ho, K.-t. Lau, J. Leng, *et al.*, "Critical factors on manufacturing processes of natural fibre composites," *Composites Part B: Engineering*, vol. 43, pp. 3549-3562, 2012.

[33] C. Alves, A. Silva, L. Reis, M. Freitas, L. Rodrigues, and D. Alves, "Ecodesign of automotive components making use of natural jute fiber composites," *Journal of cleaner production*, vol. 18, pp. 313-327, 2010.

[34] M. Idicula, K. Joseph, and S. Thomas, "Mechanical performance of short banana/sisal hybrid fiber reinforced polyester composites," *Journal of Reinforced Plastics and Composites*, vol. 29, pp. 12-29, 2010.

[35] P. Ravindra, M. Raman, and B. Sanjay, "Modeling and analysis of carbon fiber epoxy based leaf spring under the static load condition by using FEA," *International Journal of Emerging Science and Engineering (IJESE)*, vol. 2, pp. 39-42, 2014.

[36] A. Sailesh, R. Arunkumar, and S. Saravanan, "Mechanical properties and wear properties of kenaf–aloe vera–jute fiber reinforced natural fiber composites," *Materials Today: Proceedings*, vol. 5, pp. 7184-7190, 2018.

[37] S. Singh, D. Deepak, L. Aggarwal, and V. Gupta, "Tensile and flexural behavior of hemp fiber reinforced virgin-recycled HDPE matrix composites," *Procedia Materials Science*, vol. 6, pp. 1696-1702, 2014.

[38] L. Yan, N. Chouw, and K. Jayaraman, "Flax fibre and its composites–A review," *Composites Part B: Engineering*, vol. 56, pp. 296-317, 2014.

[39] A. Kiruthika, "A review on physico-mechanical properties of bast fibre reinforced polymer composites," *Journal of Building Engineering*, vol. 9, pp. 91-99, 2017.

[40] S. N. A. Safri, M. T. H. Sultan, M. Jawaid, and K. Jayakrishna, "Impact behaviour of hybrid composites for structural applications: A review," *Composites Part B: Engineering*, vol. 133, pp. 112-121, 2018.

[41] I. Aji, E. Zainudin, K. Abdan, S. Sapuan, and M. Khairul, "Mechanical properties and water absorption behavior of hybridized kenaf/pineapple leaf fibre-reinforced high-density polyethylene composite," *Journal of Composite Materials*, vol. 47, pp. 979-990, 2013.

[42] H.-y. Cheung, M.-p. Ho, K.-t. Lau, F. Cardona, and D. Hui, "Natural fibre-reinforced composites for bioengineering and environmental engineering applications," *Composites Part B: Engineering*, vol. 40, pp. 655-663, 2009.

[43] H. Ku, H. Wang, N. Pattarachaiyakoop, and M. Trada, "A review on the tensile properties of natural fiber reinforced polymer composites," *Composites Part B: Engineering*, vol. 42, pp. 856-873, 2011.

[44] C. M. Valencia, J. Pazos-Ospina, E. Franco, J. L. Ealo, D. Collazos-Burbano, and G. C. Garcia, "Ultrasonic determination of the elastic constants of epoxy-natural fiber composites," *Physics Procedia*, vol. 70, pp. 467-470, 2015.

[45] B. T. Węcławski, M. Fan, and D. Hui, "Compressive behaviour of natural fibre composite," *Composites Part B: Engineering*, vol. 67, pp. 183-191, 2014.

[46] D. Alvarez-Valencia, H. J. Dagher, R. A. Lopez-Anido, W. G. Davids, D. J. Gardner, and A. C. Center, "Behavior of natural-fiber/thermoplastic sheet piling," *Proceedings of the composites & polycon*, pp. 1-16, 2009.

[47] K.-L. Zhang, J.-Y. Zhang, Z.-L. Hou, S. Bi, and Q.-L. Zhao, "Multifunctional broadband microwave absorption of flexible graphene composites," *Carbon*, vol. 141, pp. 608-617, 2019.

[48] P. B a, B. P Shetty, and S. P. Singh Yadav, "Physical and mechanical properties, morphological behaviour of pineapple leaf fibre reinforced polyester resin composites," *Advances in Materials and Processing Technologies*, vol. 8, pp. 1147-1159, 2022.

[49] B. Praveena, B. P. Shetty, A. Akshay, and B. Kalyan, "Experimental study on mechanical properties of pineapple and banana leaf fiber reinforced hybrid composites," in *AIP conference proceedings*, 2020.

[50] B. Praveena, M. M. Ahmed, V. Kedambadi, and U. Kempaiah, "The design, optimisation and analysis of office chair base, based on the European standards," *International Journal of Mechanical and Production Engineering Research and Development*, vol. 8, pp. 85-92, 2018.

[51] H. V. GangaRao and P. Vijay, "Feasibility review of FRP materials for structural applications," *Report, West Virginia University, USA*, 2010.

[52] G. D. Babu, K. S. Babu, and B. U. M. Gowd, "Effect of machining parameters on milled natural fiber-reinforced plastic composites," *J. Adv. Mech. Eng*, vol. 1, pp. 1-12, 2013.

[53] J. P. Davim, L. R. Silva, A. Festas, and A. Abrão, "Machinability study on precision turning of PA66 polyamide with and without glass fiber reinforcing," *Materials & Design*, vol. 30, pp. 228-234, 2009.

[54] I. Shyha, S. L. Soo, D. Aspinwall, and S. Bradley, "Effect of laminate configuration and feed rate on cutting performance when drilling holes in carbon fibre reinforced plastic composites," *Journal of materials processing technology*, vol. 210, pp. 1023-1034, 2010.

[55] N. Bhatnagar, N. Naik, and N. Ramakrishnan, "Experimental investigations of drilling on CFRP composites," *Material and Manufacturing Process*, vol. 8, pp. 683-701, 1993.

[56] V. K. Mahakur, S. Bhowmik, and P. K. Patowari, "Machining parametric study on the natural fiber reinforced composites: A review," *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, vol. 236, pp. 6232-6249, 2022.

[57] A. Hussain, A. Farooq, M. I. Bassyouni, H. H. Sait, M. A. El-Wafa, S. W. Hasan, *et al.*, "Pyrolysis of Saudi Arabian date palm waste: A viable option for converting waste into wealth," 2014.

[58] M. Munir, M. Alhajhoj, M. E. Mohammed, H. Ghazzawy, M. Elgarawany, M. El-Habbab, *et al.*, "Effects of Date Palm Biochar on Growth, Yield and Photosynthetic Capacity of Cucumber (Cucumis sativus L.) Under

Glasshouse Conditions," *Pakistan Journal of Life & Social Sciences*, vol. 18, 2020.

[59] M. F. Awalludin, O. Sulaiman, R. Hashim, and W. N. A. W. Nadhari, "An overview of the oil palm industry in Malaysia and its waste utilization through thermochemical conversion, specifically via liquefaction," *Renewable and Sustainable Energy Reviews*, vol. 50, pp. 1469-1484, 2015.

[60] A. Alawar, A. M. Hamed, and K. Al-Kaabi, "Characterization of treated date palm tree fiber as composite reinforcement," *Composites Part B: Engineering*, vol. 40, pp. 601-606, 2009.

[61] Y. Ali, "Use of date palm leaves compost as a substitution to peatmoss," *Am. J. Plant Physiol*, vol. 3, pp. 131-136, 2008.

[62] M. U. H. Joardder, M. S. Uddin, and M. N. Islam, "The utilization of waste date seed as bio-oil and activated carbon by pyrolysis process," *Advances in Mechanical Engineering*, vol. 4, p. 316806, 2012.

[63] J. H. Spangenberg, A. Fuad-Luke, and K. Blincoe, "Design for Sustainability (DfS): the interface of sustainable production and consumption," *Journal of Cleaner Production*, vol. 18, pp. 1485-1493, 2010.

[64] U. M. Diwekar and Y. N. Shastri, "Green process design, green energy, and sustainability: A systems analysis perspective," *Computers & chemical engineering*, vol. 34, pp. 1348-1355, 2010.

[65] R. Taufik, M. Muhamad, and H. Hasib, "Feasibility study of natural fiber composite material for engineering application," *Journal of Mechanical Engineering and Sciences*, vol. 6, pp. 940-948, 2014.

[66] L. Yan, B. Kasal, and L. Huang, "A review of recent research on the use of cellulosic fibres, their fibre fabric reinforced cementitious, geo-polymer and polymer composites in civil engineering," *Composites Part B: Engineering*, vol. 92, pp. 94-132, 2016.

[67] P. J. Herrera-Franco and A. Valadez-Gonzalez, "Mechanical properties of continuous natural fibre-reinforced polymer composites," *Composites Part A: applied science and manufacturing*, vol. 35, pp. 339-345, 2004.

[68] Y. Ali, "Use of Date Palm Leaves compost as a substitution to peatmoss," *American Journal of Plant Physiology*, vol. 5, pp. 170-175, 2010.

[69] W. Abdelmajeed Labib, "Utilisation of date palm fibres in cement-based composites: A feasibility study," in *IOP conference series: materials science and engineering*, 2019, p. 012028.

[70] A. Al-Khanbashi, K. Al-Kaabi, and A. Hammami, "Date palm fibers as polymeric matrix reinforcement: fiber characterization," *Polymer composites*, vol. 26, pp. 486-497, 2005.

[71] K. Al-Kaabi, A. Al-Khanbashi, and A. Hammami, "Date palm fibers as polymeric matrix reinforcement: DPF/polyester composite properties," *Polymer composites*, vol. 26, pp. 604-613, 2005.

[72] A. Sbiai, A. Maazouz, E. Fleury, H. Souterneau, and H. Kaddami, "Short date palm tree fibers/polyepoxy composites prepared using RTM process: effect of tempo mediated oxidation of the fibers," *BioResources*, vol. 5, pp. 672-689, 2010.

[73] S. Mahdavi, H. Kermanian, and A. Varshoei, "Comparison of mechanical properties of date palm fiber-polyethylene composite," *BioResources*, vol. 5, pp. 2391-2403, 2010.

[74] A. Bendahou, H. Kaddami, H. Sautereau, M. Raihane, F. Erchiqui, and A. Dufresne, "Short palm tree fibers polyolefin composites: Effect of filler content and coupling agent on physical properties," *Macromolecular Materials and Engineering*, vol. 293, pp. 140-148, 2008.

[75] S. N. Rafeeq, I. M. Abdulmajeed, and A. R. Saeed, "Mechanical and thermal properties of Date Palm Fiber and Coconut shell particulate filler reinforced Epoxy composite," *Indian J. Appl. Res*, vol. 3, pp. 89-92, 2013.

[76] M. Gururaja and A. H. Rao, "A review on recent applications and future prospectus of hybrid composites," *International Journal of Soft Computing and Engineering*, vol. 1, pp. 352-355, 2012.

[77] A. Shahzad, "Impact and fatigue properties of hemp–glass fiber hybrid biocomposites," *Journal of Reinforced Plastics and Composites*, vol. 30, pp. 1389-1398, 2011.

[78] M. R. A. Refaai, R. M. Reddy, M. I. Reddy, B. S. H. Khan, V. Nagaraju, and S. P. Kumar, "Investigation on physical and mechanical characteristics of date palm fiber reinforced aliphatic epoxy hybrid composites," *Advances in Polymer Technology*, vol. 2022, pp. 1-11, 2022.

[79] S. W. Ghori and G. S. Rao, "Fiber loading of date palm and kenaf reinforced epoxy composites: tensile, impact and morphological properties," *Journal of Renewable Materials*, vol. 9, p. 1283, 2021.

[80] M. Y. Abdellah, M. G. Sadek, H. Alharthi, and G. Abdel-Jaber, "Mechanical, thermal, and acoustic properties of natural fibre-reinforced polyester," *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering*, p. 09544089231157638, 2023.

[81] A. Supian, M. Jawaid, B. Rashid, H. Fouad, N. Saba, H. N. Dhakal, *et al.*, "Mechanical and physical performance of date palm/bamboo fibre reinforced epoxy hybrid composites," *journal of materials research and technology*, vol. 15, pp. 1330-1341, 2021.

[82] A. Yousefpour, M. Hojjati, and J.-P. Immarigeon, "Fusion bonding/welding of thermoplastic composites," *Journal of Thermoplastic composite materials*, vol. 17, pp. 303-341, 2004.

[83] M. Sanjay, G. Arpitha, L. L. Naik, K. Gopalakrishna, and B. Yogesha, "Applications of natural fibers and its composites: an overview," *Natural Resources*, vol. 7, pp. 108-114, 2016.

[84] F. M. Al-Oqla, S. Sapuan, M. R. Ishak, and A. Nuraini, "Predicting the potential of agro waste fibers for sustainable automotive industry using a decision making model," *Computers and Electronics in Agriculture*, vol. 113, pp. 116-127, 2015.

[85] M. Alaaeddin, S. Sapuan, M. Zuhri, E. Zainudin, and F. M. AL-Oqla, "Properties and common industrial applications of polyvinyl fluoride (PVF) and polyvinylidene fluoride (PVDF)," in *IOP Conference Series: Materials Science and Engineering*, 2018, p. 012021.

[86] F. M. AL-Oqla, S. Sapuan, and O. Fares, "Electrical–based applications of natural fiber vinyl polymer composites," in *Natural fibre reinforced vinyl ester and vinyl polymer composites*, ed: Elsevier, 2018, pp. 349-367.

[87] F. M. Al-Oqla and S. Sapuan, *Advanced processing, properties, and applications of starch and other bio-based polymers*: Elsevier, 2020.

[88] M. K. Singh, G. Arora, R. Tewari, S. Zafar, H. Pathak, and A. K. Sehgal, "Effect of pine cone filler particle size and treatment on the performance of recycled thermoplastics reinforced wood composites," *Materials Today: Proceedings*, vol. 62, pp. 7358-7363, 2022.

[89] R. Tewari, M. K. Singh, and S. Zafar, "Utilization of forest and plastic wastes for composite manufacturing using microwave-assisted compression molding for low load applications," *Journal of Polymer Research*, vol. 28, pp. 1-14, 2021.

[90] M. Singh, N. Verma, and S. Zafar, "Conventional processing of polymer matrix composites," in *Lightweight Polymer Composite Structures*, ed: CRC Press, 2020, pp. 21-66.

[91] M. K. Singh and S. Zafar, "Effect of layering sequence on mechanical properties of woven kenaf/jute fabric hybrid laminated microwave-processed composites," *Journal of Industrial Textiles*, vol. 51, pp. 2731S-2752S, 2022.

[92] M. K. Singh and S. Zafar, "Influence of microwave power on mechanical properties of microwave-cured polyethylene/coir composites," *Journal of Natural Fibers*, 2018.

[93] R. Tewari, M. K. Singh, S. Zafar, and S. Powar, "Parametric optimization of laser drilling of microwave-processed kenaf/HDPE composite," *Polymers and Polymer Composites*, vol. 29, pp. 176-187, 2021.

[94] N. Pundhir, S. Zafar, and H. Pathak, "Performance evaluation of HDPE/MWCNT and HDPE/kenaf composites," *Journal of Thermoplastic Composite Materials*, vol. 34, pp. 1315-1333, 2021.

[95] C.-K. Jeon, J.-S. Lee, H. Chung, J.-H. Kim, and J.-P. Park, "A study on insulation characteristics of glass wool and mineral wool coated with a polysiloxane agent," *Advances in Materials Science and Engineering*, vol. 2017, 2017.

[96] F. Langfeldt and W. Gleine, "Improved sound transmission loss of glass wool with acoustic metamaterials," *Proc 26th Int Congr Sound Vib ICSV*, vol. 2019, 2019.

[97] I. F. Ghazi and R. I. Jaddan, "Thermal conductivity characterization of epoxy based composites reinforced with date palm waste particles," in *Journal of Physics: Conference Series*, 2021, p. 012144.

[98] M. Mohammad, N. N. Syukri, and M. Nuawi, "Sound properties investigation of date palm fiber," in *Journal of Physics: Conference Series*, 2019, p. 012003.

[99] D. Chandramohan and J. Bharanichandar, "Natural fiber reinforced polymer composites for automobile accessories," *American Journal of Environmental Sciences*, vol. 9, p. 494, 2013.

[100] J. Holbery and D. Houston, "Natural-fiber-reinforced polymer composites in automotive applications," *Jom*, vol. 58, pp. 80-86, 2006.

[101] M. Dweib, B. Hu, A. O'donnell, H. Shenton, and R. Wool, "All natural composite sandwich beams for structural applications," *Composite structures*, vol. 63, pp. 147-157, 2004.

[102] D. S. Bavan and G. M. Kumar, "Potential use of natural fiber composite materials in India," *Journal of Reinforced Plastics and Composites*, vol. 29, pp. 3600-3613, 2010.

[103] R. Swamy, G. M. Kumar, Y. Vrushabhendrappa, and V. Joseph, "Study of areca-reinforced phenol formaldehyde composites," *Journal of reinforced plastics and composites*, vol. 23, pp. 1373-1382, 2004.

[104] S. Das, "Jute composite and its applications," in *International workshop, IJSG, Indian Jute Industries Research Association, Kolkata, India. www. jute. org (2009, accessed July 2010)*, 2009.

[105] Q. Li and L. M. Matuana, "Surface of cellulosic materials modified with functionalized polyethylene coupling agents," *Journal of Applied Polymer Science*, vol. 88, pp. 278-286, 2003.

[106] C. U. Maheswari, K. O. Reddy, E. Muzenda, M. Shukla, and A. V. Rajulu, "A comparative study of modified and unmodified high-density polyethylene/borassus fiber composites," *International Journal of Polymer Analysis and Characterization*, vol. 18, pp. 439-450, 2013.

[107] N. Uddin and R. R. Kalyankar, "Manufacturing and structural feasibility of natural fiber reinforced polymeric structural insulated panels for panelized construction," *International journal of polymer science*, vol. 2011, 2011.

[108] R. Burgueno, M. J. Quagliata, A. K. Mohanty, G. Mehta, L. T. Drzal, and M. Misra, "Load-bearing natural fiber composite cellular beams and panels," *Composites Part A: applied science and manufacturing*, vol. 35, pp. 645-656, 2004.

[109] B. V. Ramnath, V. Manickavasagam, C. Elanchezhian, C. V. Krishna, S. Karthik, and K. Saravanan, "Determination of mechanical properties of intra-layer abaca–jute–glass fiber reinforced composite," *Materials & Design*, vol. 60, pp. 643-652, 2014.

[110] K. Ghavami, "Bamboo as reinforcement in structural concrete elements," *Cement and concrete composites*, vol. 27, pp. 637-649, 2005.

[111] M. Golbabaie, "Applications of Biocomposites in Building Industry Department of Plant Agriculture," ed: University of Guelph, Ontario, 2006.

[112] S. Chakraborty, S. P. Kundu, A. Roy, B. Adhikari, and S. B. Majumder, "Effect of jute as fiber reinforcement controlling the hydration characteristics of cement matrix," *Industrial & Engineering Chemistry Research*, vol. 52, pp. 1252-1260, 2013.

[113] M. Ali and N. Chouw, "Experimental investigations on coconut-fibre rope tensile strength and pullout from coconut fibre reinforced concrete," *Construction and Building Materials*, vol. 41, pp. 681-690, 2013.

[114] L. Yan and N. Chouw, "Experimental study of flax FRP tube encased coir fibre reinforced concrete composite column," *Construction and Building Materials*, vol. 40, pp. 1118-1127, 2013.

[115] R. Jarabo, M. Monte, E. Fuente, S. Santos, and C. Negro, "Corn stalk from agricultural residue used as reinforcement fiber in fiber-cement production," *Industrial Crops and Products*, vol. 43, pp. 832-839, 2013.

[116] R. Jarabo, M. C. Monte, A. Blanco, C. Negro, and J. Tijero, "Characterisation of agricultural residues used as a source of fibres for fibre-cement production," *Industrial Crops and Products*, vol. 36, pp. 14-21, 2012.

[117] S. Sapuan, J. Kho, E. Zainudin, Z. Leman, B. Ali, and A. Hambali, "Materials selection for natural fiber reinforced polymer composites using analytical hierarchy process," 2011.

[118] A. Anand, M. I. U. Haq, K. Vohra, A. Raina, and M. Wani, "Role of green tribology in sustainability of mechanical systems: a state of the art survey," *Materials Today: Proceedings*, vol. 4, pp. 3659-3665, 2017.

[119] M. Karus and M. Kaup, "Natural fibres in the European automotive industry," *Journal of Industrial Hemp*, vol. 7, pp. 119-131, 2002.

[120] M. Jawaid and H. A. Khalil, "Cellulosic/synthetic fibre reinforced polymer hybrid composites: A review," *Carbohydrate polymers*, vol. 86, pp. 1-18, 2011.

[121] M. Jawaid, H. A. Khalil, and A. A. Bakar, "Mechanical performance of oil palm empty fruit bunches/jute fibres reinforced epoxy hybrid composites," *Materials Science and Engineering: A*, vol. 527, pp. 7944-7949, 2010.

[122] B. Yousif, A. Shalwan, C. W. Chin, and K. Ming, "Flexural properties of treated and untreated kenaf/epoxy

composites," *Materials & Design*, vol. 40, pp. 378-385, 2012.

[123] M. A. AlMaadeed, Z. Nógellová, M. Mičušík, I. Novák, and I. Krupa, "Mechanical, sorption and adhesive properties of composites based on low density polyethylene filled with date palm wood powder," *Materials & Design*, vol. 53, pp. 29-37, 2014.

[124] M. Shahruzzaman, S. Biswas, M. M. Islam, M. S. Islam, M. S. Rahman, P. Haque, *et al.*, "Furniture: Eco-Friendly Polymer Composites Applications," *Encyclopedia of Polymer Applications, 1st ed.; Mishra, M., Ed*, pp. 1517-1547, 2019.

[125] M. G. Sadek, M. Y. Abdellah, A. H. Backar, and G. Abdel-Gaber, "A Review on Failure Analysis of Date Palm Fiber Reinforced Polymer Composites," *SVU-International Journal of Engineering Sciences and Applications*, vol. 5, pp. 99-110, 2024.

[126] M. Y. Abdellah, A. Seleem, W. Marzok, A. Hashem, and A. H. Backer, "Tensile and Imp act Properties of Hybrid Date Palm Fibre Composite Structures Embedded with Chopped Rubber," *Int. J. Eng. Res. Appl*, vol. 12, pp. 54-66, 2022.

[127] M. Y. Abdellah, M. K. Hassan, A. F. Mohamed, and K. A. Khalil, "A novel and highly effective natural vibration modal analysis to predict nominal strength of open hole glass fiber reinforced polymer composites structure," *Polymers*, vol. 13, p. 1251, 2021.