**Date palm leaf (**Processing and Properties of Date Palm Fibers and Its Composites)

The date palm tree is characterized by numerous offshoots produced at its trunk’s base. The trunk of the date palm tree is covered with persistent grayish leaf bases. It is surmounted by a handsome array of pinnate divided long leaves and needle sharp fronds. Usually, around 10–20 new leaves are produced annually. The leaves of the date palm are subtended by a cylindrical sheath of reticulate mass of tough, fibrous material, at their bases. These together form a tight protective envelope for the terminal bud . A young actively bearing date palm tree showing offshoots is shown in Fig. 1.2 and fruit of the date palm is seen in Fig. 1.3 . Detailed morphological traits of date palm tree leaf can be shown in Fig. 1.4 , where different parameters of the leaf can be demonstrated like the leaf length, thickness, angle, length of leaf let part, rachis thickness, leaf lets number as well as others .Physical properties of the natural fibers are crucial in determining their suitability for different industrial applications as well as natural fiber composites. Fiber’s length, diameter, and density as well as aspect ratio, thermal conductivity, cost, and availability are considered as key criteria and properties that can determine the potential usage of any natural fiber type in different industrial applications. Date palm fiber can be considered as one of the most available natural type comparing to other natural fiber used in polymer composites for automotive industry. On the other hand, the fiber density is one of the most important physical properties that contribute implementing natural fibers in different applications. That is, it can lead to lower weight composites suitable for automotive and space applications.. It is noticed that date palm fiber has a lower density as compared to other natural fibers which give it an added value in the field of natural fiber composites.Palm Fibers and Its Composites have Characteristics of the date palm production System. Its sustainability in harsh climatic, High efficiency in resource utilization, High productivity, High nutritional value of date fruit ,Long productive life, Enhance agriculture development by creating equable ,microclimate within oasis ecosystems ,Helpful in reducing decertify cation risks.

Date palm tree can produce annually large number of natural fibers that can be utilized in different industries. It is estimated that the annual date palm agricultural wastes are more than 20 kg of dry leaves and fibers for each date palm tree . Moreover, the date palm tree produces another type of wastes as date pits which are about of 10 % of the date fruits . Unfortunately, these agriculture wastes are not properly utilized in any biological process or industrial applications, in most of countries, despite of their contents of potential amount of cellulose, hemicelluloses, lignin, and other compounds. Typical date palm fibers can be seen in Fig. 1.5.





**Availability in Oman?**

Date palm ( *Phoenix dactylifera* L.) trees as one of mankind’s oldest cultivated plants belong to the family of Palmae (Arecaceae). It has played a vital role in daily life activities in the Middle East particularly the Arabian Peninsula since 7,000 years .Recently, the worldwide production of date palm fruits is continuously increasing which indicates the importance of the date palm trees. The utilization and industrialization of dates are distributed among several in Oman .

 **The Strength of Date palm?**

Moreover, these NFC have several advantages over the traditional types of materials like the low costs and density as well as acceptable specific strength and modulus. which can lead to low weight products. Consequently, the natural fiber reinforced polymer composites (NFRPC), (simply NFC), became a valuable alternative material type for wide range of applications. In this NFC, natural fibers (such as jute, hemp, sisal, oil palm, kenaf, and flax) are utilized to be fillers or reinforcing material for polymer-based matrices. Such utilization of natural fibers can decrease the amount of waste disposal problems and enhance reducing in environmental pollution. Such materials are attractive from environmental point of view where they can be used as an alternative to the traditional glass/carbon polymer composites .

### **DPL Fiber Preparation**

At first, fibers were prepared compatible by taking out the leaf from date palm tree . After that, these fibers were washed with distilled water, followed by drying at 70 °C for 1 day to eradicate the moisture completely. Now, these untreated fibers or so-called prepared fibers were processed for chemical modifications (Alkaline Treatment)

### Chemical Modifications of DPL Fibers

#### **Alkaline Treatment**

Alkaline treatment (mercerization) is one of the most popular chemical treatments of natural fibers. The major modification done by this treatment is the disruption of hydrogen bonding in the network structure, herewith increasing surface roughness. Alkaline treatment by adding of aqueous sodium hydroxide (NaOH) to natural fiber can remove a certain amount of lignin, wax, and oils covering the external surface of the fiber cell wall, depolymerizes cellulose, and exposes the short length crystallites Thus, alkaline processing can directly affect the cellulosic fibril, the degree of polymerization, and the extraction of lignin and hemi cellulosic compounds

Alkaline modification, at first the so-called prepared fibers of the date palm leaves were thoroughly washed by sodium hydroxide solution (6 wt % NaOH) for 48 h at room temperature. After that, the NaOH-treated fibers were cooled down to room temperature and rinsed several times with fresh water to remove unreacted NaOH solution (if any) from the fiber surface, and these fibers were then dried at 60 °C for 24 h. This method was adopted to activate the –OH groups on the lignin and cellulose in the fiber. Actually, the addition of aqueous sodium hydroxide in natural fibers leads to the ionization of the –OH groups to the alkoxide which is given as follows .These resulting fibers were termed as alkaline pretreated fiber

Fibre - OH + NaOH ® Fibre - O-Na+ + H O

2

**Mold preparation:**

The mounding box is manually prepared by template consists of three plates .Dimensions of 300 × 300 × 300 mm were used. Middle section to

The shape of the frame was placed on the plate surface, the length of the specified fiber. And the wax is coated bottom side .The resin is mixed with the hardener due to the increasing the hardness properties of resin. The palm is fiber is collected manually and it is cut required size. The wax is used for easily removing the composite material from the mold box.

Inside the mold box the resin and fiber are pasted alter natively like a layer .The wax is pasted before the first layer and also after the last layer .It takes 24hr for complete the work in atmosphere .After completion of work the job is includes the test of thermal conductive ,density ,flexural , hardness and impact.

The composite fabrication of the composite material was carried out through the hand-layup technique. The top and bottom plate surface of the mold and the walls were coated with remover and allowed to dry. The top and bottom plates are to be covered and press the fiber after the epoxy resin is applied.



 Figure

**Flexural test for date palm leaf composite (**<https://www.testresources.net/applications/test-types/flexural-test/>)

Flexure tests are generally used to determine the flexural modulus or flexural strength of a material. A flexure test is more affordable than a tensile test and test results are slightly different. The material is laid horizontally over two points of contact (lower support span) and then a force is applied to the top of the material through either one or two points of contact (upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample.

Unlike a compression test or tensile test, a flexure test does not measure fundamental material properties. When a specimen is placed under flexural loading all three fundamental stresses are present: tensile, compressive and shear and so the flexural properties of a specimen are the result of the combined effect of all three stresses as well as (though to a lesser extent) the geometry of the specimen and the rate the load is applied.

The most common purpose of a flexure test is to measure flexural strength and flexural modulus. Flexural strength is defined as the maximum stress at the outermost fiber on either the compression or tension side of the specimen. Flexural modulus is calculated from the slope of the stress vs. strain deflection curve. These two values can be used to evaluate the sample materials ability to withstand flexure or bending forces.

Flexural three-point bending tests (3PBT) were conducted with two types of fibre disposition (longitudinal and transverse) and performed on a universal testing machine (Instron 4426) according to ASTM D790M (see Figure 5). The bending modulus of each sample was determined by calculating the slope of the stress-strain curve between 0.1 and 0.3% of the strain. The crosshead speed was set at 1mm/min, and a 1kN loadcell was used during the test. The load and the flexural displacement are registered during the complete test. At least four samples were tested in each configuration. See Table for the sample dimensions.

|  |
| --- |
| Flexural\*( GPa) |
|  40.2 |
|  38.2 |
|  ------- |
|  41.1 |
|  --------- |
|  37.8 |

* 1. **Conclusions**

The DPLC became recently a valuable type of materials due to their desirable eco- friendly characteristics. Adopting the natural wastes and resources in finding alter- native low-cost materials can enhance the industrial sustainability as well as reducing the environmental pollution. Biodegradability, low cost, low relative density, and the high specific strength characteristics are the main added value steps of the natural fiber composites. Widening the application of such materials can contribute to the human living standards as well as the green environmental indices. Many potential natural fiber types are still undiscovered due to the improper evaluations of such fibers. Date palm fiber is one of the most competitive fiber types for producing natural composites. Several studies had demonstrated its capability to produce different composites with various thermo plastics and thermoset polymers. Proper fiber treatment can enhance the role of date palm fiber in supporting the natural composites with more desirable characteristics to contribute the sustainable industrial applications. Further research is required to improve the natural fiber performance and to overcome their drawbacks like the moisture absorption, inadequate toughness, and reduced long-term stability for outdoor application.

# Future Developments

Renewable energy and steps toward achieving more sustainable societies are the key drivers for conducting more scientific research regarding different aspects of natural resources. A proper utilization of the available resources can enhance better living standards as well as reducing energy consumption behavior. Implementing natural fibers for getting more bioenergy as an alternative source to the fossil fuel energy, as well as utilizing the natural fiber/nanoclay reinforced polymeric materials are emphasized by several governing and industrial sectors. Achieving the optimum desired properties for the completely recyclable hybrid composites are the future game of the world to expand the sustainable design possibilities that can widen the applications of such composite to reach all aspects of the modern living standards. Hybrid recyclable packaging material from natural fiber developed at lower cost but contributes to the sustainability as well as functionality. Mechanically stronger materials are recommended for the packaging as well as gas sensitive materials such as electronic and pharmaceutical packaging. Although those hybrid materials are degradable, the poor interfacial adhesion and the lack of compatibility between the filler and the matrix limited their widespread commercial impact.

# Summary

DPLC as eco-friendly materials, have been emerged as an alternative to the traditional glass/carbon-reinforced polymer composites. They are attractive materials for different applications like packaging, furniture, and automotive industries. Such materials have several advantages like, the low cost, acceptable mechanical proper- ties, good thermal and acoustic insulating properties, availability, CO2 sequestration enhanced energy recovery, etc. The properties and performance of the final natural fiber composites depend on the properties of both the matrix and filler as well as their interfacial bonding. Both physical and mechanical treatment processes were performed on the cellulosic fibers to enhance the interfacial bonding characteristics of the natural fiber composites. Different factors and criteria can affect the performance of the produced natural fiber composites. Some of these criteria affect the selection of the composite constituents (matrix and fillers), whereas others can determine the final performance of the produced product of such materials. Wide range of physical, biological, mechanical, environmental as well as economic properties of the polymer composite have to be investigated to optimize and widen their potential applications.

The petroleum derived thermoplastics and thermosets are widely used for producing different natural fiber composites oriented for various industrial applications. The potential and competitiveness of the palm fiber was proved for different industrial applications particularly the automotive ones. It can be considered that date palm fiber is one of the most available natural fiber types all over the word. It can be utilized with different polymer matrices to produce satisfactorily strong composites. The effect of the chemical treatment of the date palm fiber had been proven to increase its final mechanical properties as well as its reinforced polymer composites.