Physical and Mechanical Properties of Medium Density Fiber Board Made of Palm Fronds and Trunks

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ABSTRACT---- ***The current study was conducted in both date palm research center and polymers research center / Basrah University during the period 2015-2016 . the result showed that the average length of female trunk fibers ranging between (716 -879) micrometer and its diameter (22.4-22.7) micrometer . The study also showed that the average length and fiber diameter of petiole (leaf base) and rachis of three cultivars (Kadrawi ,Zahdi and Sayer) were not significantly differ and ranging between (1010- 1258) micrometer and (14.2-22.6) micrometer respectively. This study also include preparation of medium density fiber board(MDF) made of palm frond and trunk fibers. The*** flexural ***strength reach 3.5 Mp and compressive strength reach 6.6 Mp This study also revealed that Bending strength and compressive strength of boards are depending on the ratio of cement added .the physical properties are improved by additive the cement, therefor we can used the cement with the (poly vinylestate and polol) to improved water absorption and thickness swelling of board. MDF density are about 250-710 Kg/m3. The bending test are about 1.7-3.5*** **Mp**

Keywords----- Date palm trunk , date palm fronds , date palm petiole, date palm research center ,

1. INTRODUCTION

Fiber is an elongated cell with tapering end and thick secondary cell wall, non living at maturity , they are found in different plant part (Dickison ,2000) . fiber are divided into two groups xylary fibers and extraxylary fibers . (Esau ,1950).according to Paula J. Rudall (2007) extraxylary (cortical fibres) are of economic use, such as flax and hemp.

In monocotyledon plant fiber enclose vascular bundles in the form of strand or bundle cap associated with vascular bundles (Dickison ,2000) According to A. Al-Khanbashi, et.al (2005) date palm fiber is cylindrical in shape, SEM micrograph of a raw fiber show that its surface contain a large number of uncompleted grown fibers (expected to be residual lignin) and artificial impurities (sand and dust).

Fiber length differ according to the source ; for the soft fiber its length range from 0.8- 6 mm in Jute , 5- 55 mm in cannabis ,9-70mm in linum (Linum usitatissimum L). and 50-250mm in ramie .While in hard fiber its length ranging between 0.8-8 mm in sisals and bow string hemp between 1-7mm (Al-ani and Kaser,1979) . In date palm fiber length were varying between 1-1,3 mm and its diameter between 10-40 micrometer (Mahdavi et al,2010). Leaf Stalk . Mirmehdi et al .(2010) found that the

fiber length, diameter, lumen diameter, and cell wall thickness were measured at 1393.66 µm, 18.1 µm, 7.65 µm, and 5.23 µm respectively and leaflet fibers were measured at 1413.71 µm, 15.18 µm, 7.06 µm, and 4.06 µm respectively.

Date palm trunk characterize by the presence of fully developed vascular bundles in central cylinder and some fibrous cortical bundles (Zimmermann and. Tomlinson ,1972), The general stem organisation is highly homogeneous,however there are few differences in the structure and the density of the fibrovascular bundles between the central zone and the subcortical zone; this specific organisation is called Cocos-Type (Thomas & De Franceschi, 2013) The date palm stem is composed of a narrow cortex and wide central cylinder. The cortex contains numerous fiber bundles independent of the

cylinder (Tomlison 1961) .There is no significant variation or gradient in density of vascular bundules from inner to peripheral zones, as well as, no difference were noted in these bundles from base to top. (Leila Fathi , 2014)
vascular bundles in date palm midrib similar to that found in other monocotyledon, they are distributed randomly in ground meristem, however they highly vary when moving from the base (petiole) to the apex of the leaf (rachis) (Thomas , 2013) . according to Megahed and El-Mously (1995) cross section of date palm midrib showed three zones of vascular bundles, the peripheral, transitional zone and inner zone. In the first and second zone, the fiber sheath is thick, and the vascular bundles are numerous with small parenchyma cells between them. The third zone is the broadest, where the bundles reach their highest diameter. The average width of the periphery and transition zones across the midrib is 1.265 mm. Fiber tissue percent is higher in the periphery and transition zone (38%) than in the inner or central zone (10%).
Since the mid-1960 ‘s the worldwide production and consumption of wood panel products has maintained a rapid rising trend with different rates of increase in different regions. The panel industry relies mainly on the use of wood of various species as its raw material .Raw material costs represent a significant proportion of total panel manufacturing costs . Several lignocelluloses have been used successfully produce particleboards ,fiberboards and ,to some extent, inorganic-bonded boards.
Agricultural lignocelluloses fibers ,such as rice straw and wheat straw ,can easily be crushed to form chips or particles , which are similar to wood particle or fiber, and may be used as substitutes for wood-based raw materials .In addition ,such systems contribute to recycle of agricultural wastes. In order to recycle natural resources to meet the demand created by the decrease in the available supplies of solid wood and wood-based materials , several researchers have succeeded in developing substitutes for wood particles ,using lignocelluloses fibers (yung-kyu et al.2003).
The conventional method for producing medium –density fiberboard (MDF) and high-density fiberboard (HDF) uses wood-based raw materials, particularly softwood ,hardwood , and mixtures of diverse wood species. However, expected wood shortages, forestry regulations, and the presumed lower cost of non-wood materials have prompted MDF and panel –board producers worldwide to explore alternative source s of lignocelluloses fibers.the Interest in producing MDF panels from agricultural waste is not new : among the first installations of an Asplundh Deliberator to produce fiber and fiberboard in the United States was at Celotex Corporation in Marrero in 1937 ; insulation board was produced and the raw material was bagasse (Soren Halvarsson et al.(2010). There are several advantages from using recovered materials for various composites. First, the use of these materials in products made by the forest products industry will contribute greatly to long-term sustainable development and forest ecosystem management ,and it will allow markets for wood-based composites to grow while minimizing the use of virgin timber. Secondly ,wood-based composites of varied types are opaque, colored, painted or overlaid .Consequently recovered fibers used for composites do not require extensive cleaning and refinement to remove adhesives ,inks, dyes, etc. Thus, composites provide an unusually favorable option for the recycling of waste wood and paper .(John A,Youngquist,1997)
Iraq today has 17 million date palm (Ministry of Planning,2014)* .in Basra governorate,more than 2740700 palms(Ebrahim, 2011) and such a large numbers of palm annually producing a huge amount of trunks and palm fronds that can be a potential material for particleboard manufacturing. Using date palm fibers for manufacturing particleboards are a good solution for raw materials (Salem,E.Z. et al.2014)
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 (Al-Oqlaand Sapuan 2014).There for the current research aims to use these residues(trunk fibers) in the panel industry .

2. MATERIAL AND METHODS

Trunk crude fiber of male and female fiber (fig. 1) and fronds of three date palm cultivars, Sayer, Khadrawi and ZAHDI)were collected from the Qurna region located 70 km south of Basra province. small pieces of each of the trunk (mail and femail) Leaf Base and rachis were taken for each cultivar . For fiber study in above mentioned parts, one gram was macerated in Jeffrey solution consisting of 10% nitric acid and 10% acid, chromic and left for a whole night in the paraffin oven and under temperature not exceed 60 ° C, samples are washed gently with distilled water and then boiled for one hour. after that samples were cooled and crushed strongly in watch glass. one drop of the solution examined under a light microscope equipped with a digital camera was used to take images of fibers (Johansson in 1940, Said S. Hegazy 1,2,* and Khaled Ahmed , 2015)
Palm trunks fiber were used as a raw material (fig. 1).Poly vinyl acetate (PVA) and polyol (3:1)resins adhesive were used as adhesives and Type T Portland cement (150). To prepare palm trunks, we first removed the impurities ,then washed and dried for two days under the sun. Finally the palm trunk fibers were grounded with **volume graduate (600µ)**

Mixture preparations

The mixture preparations of medium density fiber board were shown in table (1) where the water :cement ratio is 0.6 by weight ,and the PVA ratio is 3:1 by weight ,respectively. The mixture proportions of boards listed in table (1)

Table (1) mixture proportions of boards

Sample	(PVA/PO)(311%)	Palm trunks	Cement
A1	10%	80	10
A2	10%	70	20
A3	10%	60	30
A4	10%	50	40
A5	10%	40	50

Each batch of materials was prepared for five samples with the size of (50x50x50 mm) for compressive test, three samples with (100x100x10mm) for the absorption test and balk specific gravity test ,six samples with (250x350x20mm) for bending test ,one with (200x200x10mm) for heat –resistant capability. All samples were placed on the vibration table to shake the surface of samples were leveled to smooth by the towel ,sample were removed from the mold 24h later and placed indoor for caring and testing .Bulk density and water absorption of samples in accordance with ASTM C1185,compression strength test (ASTMD 1037) and flexural strength test (ASTM C1185),and thermal conductivity in accordance with (ASTM 518)

3. RESULTS AND DISCUSSION

Table (2) showed that the average lengths of male and female fibers trunk are approximately similar and there is no significant differences, but they were shorter than that of petiole fibers and leaf base fibers. However this findings are in contrast with previous studies, Mahdavi et al(2010) revealed that the length of fiber trunk was longer than the petiole and rachis. This contraction can be attributed to the difference in the studied varieties or to the method use for fiber maceration.

Average fiber diameter of both trunk and rachis are nearly similar and more than that of petiole. According to ZHAI (2013) date palm fiber length (*Phoenix dactylifera*) ranging between 1.28 (±0.29)mm and diameter 17.0 (±3.3)mm

Table (2) Fhbers length and their dimensions in three plant parts ((trunk , petiole and rachis)

Sample	Fiber length	Fiber diameter
Female trunk	1260 (716) 373	24.9 (22.4) 8.3
Male trunk	1470 (879) 373	24.0 (22.7) 22.5
Kadrawi Petiole (leaf base)	1470 (1026) 622.5	24.9 (14.2) 16.6
Zahdi Petiole (Leaf base)	1680 (1026) 580	24.9 (15.8) 8.3
Sayer Petiole (Leaf base)	1470 (1010) 580	16.6 (15.0) 8.3
Kadrawi Rachis	1680 (1021) 370	42.0 (22.6) 21.0
Zahdi Rachis	1722 (1104) 373	42.0 (22.6) 21.0
Sayer Rachis	1680 (1258) 373	42.0 (21) 21.0
LSD.	590.79	15.79

Bulk density and water absorption

The Bulk density and water absorption were measured accord a Ace with(ASTM C1185) , The results are shown in table 2&table 3 . The bulk density was increased with cement ratio decreasing and the water absorption was decreased with decreasing of cement /ratio because the addition of cement particles which filled the vacancies in polymer composite materials .

Compressive strength and flexural strength:-

The specimens were tested at the material age of 28 days in compression (ASTM D1037) and flexural strength test (ASTM C1185), and the experimental results are shown in table (4) . The compressive strength of the boards with the value 2.3-6.6 N/mm2. mm^{2i} is lower than that of comparison material with 7N/mm .

Thermal conductivity :-

The medium density fiber board should have heat resistant capacity, Here we examine the heat resistant capability of cement boards by using the thermal conductivity in accordance with (ASTM 518) and vestals which are shown in table (5) The value of thermal conductivities of the conductivities comparison material was measured and is 0.826(watt/m.c˚). for the specimens , the values of thermal is within 0.282-0.345 (watt/m.c˚),lesser than comparison material.

Table (3) Bulk density and water absorption of MDF

Sample	Bulk density (1Kg/m^3)	Water absorption %
A1	250	70
A2	375	65
A3	470	56
A4	590	47
A5	710	38

Table (4) strength of MDF

Sample	Compressive strength N/mn^2	Flexural strength N/mn^2
A1	2.3	3.5
A2	3.4	3.1
A3	4.1	2.7
A4	5.3	2.3
A5	6.6	1.7

Table(5) thermal conductivity of MDF

Sample	Thermal conductivity (watt/m.c˚)
A1	0.345
A2	0.386
A3	0.331
A4	0.291
A5	0.282

Fig. 1. Crude date palm fibers

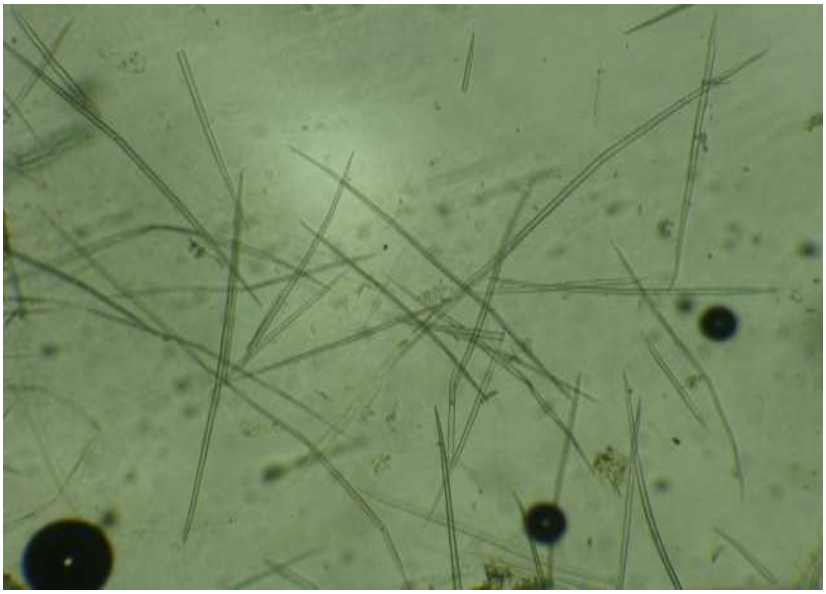

Fig.2. Date palm fibers

Fig.3. High magnification of date palm fiber

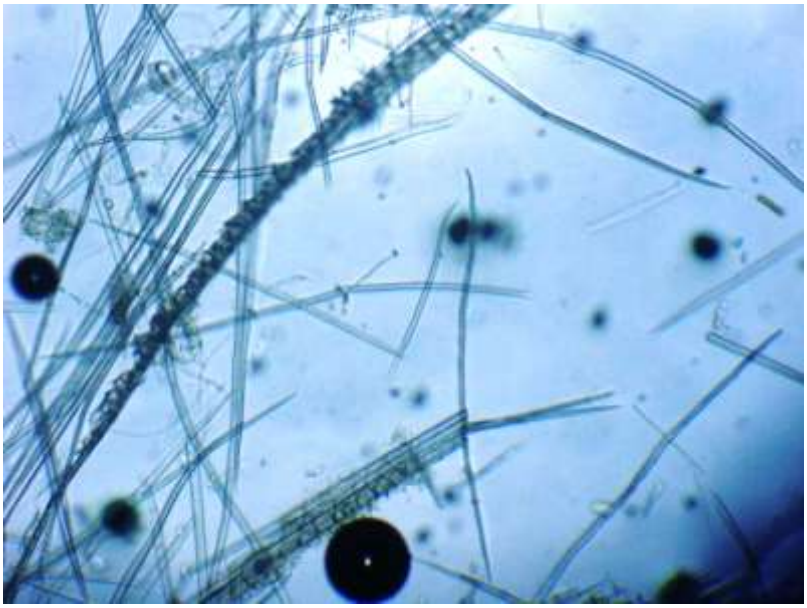

Fig 4 Separation of fiber from fiber strand.

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