Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

*Journal by Innovative Scientific Information & Services Network*

**RESEARCH ARTICLE** BIOSCIENCE RESEARCH, 2019 16(2): 1862-1875. **OPEN ACCESS**

# Evaluation of Some Physical and Mechanical Properties of Date Palm Trunk

**Seyed Meisam Mazloumzadeh and Mansoureh Pourjafar**

Higher Educational Complex of Saravan, Saravan, Sistan and Baluchestan, **Iran.**

.

***Correspondence:** m.s.pourjafar@gmail.com **Accepted: 24 May** 2019 **Published online:** 02 June. 2019

On the physical-mechanical properties of tree trunk wood, many species of trees have been thoroughly investigated, but in the case of date palm stem, so far, nothing has been done except for limited cases. In this study, some physical and mechanical properties of date palm trunk of the most important date cultivars in Sistan and Baluchestan province (Mazafati , Rabbi and Zardan), by ages between 10 to 50 years old were investigated. These properties are as moisture content, actual and apparent mass (density), compressive strength in the longitudinal and transverse directions and flexural strength for three-dimensional wood species. The results showed that Rabbi Cultivar had the highest moisture content (11.05 %) and Zardan cultivar had the lowest moisture content (6.68 %). Also, in terms of density, Mazafati cultivar had the highest density (0.76 gr / cm$^3$) and Zardan cultivar had the lowest density (3.43 gr / cm$^3$). The results of the compressive tests showed that the compressive strength in the direction of the fiber is far more than the vertical orientation of the fiber, while the Mazafati variety has the highest compressive and flexural strength and the Zardan has the least compressive and flexural strength.

**Keywords: Specific density, Flexural strength, Mechanical properties.**

## INTRODUCTION

Iran is one of the most important producers of date fruit in the world. Sistan and Baluchistan province in Iran is the second cultivar of date palm gardens. In terms of yield per hectare, Sistan and Baluchestan province has the highest yield among the provinces (Agricultural Statistics Ministry of Jihad-e-Agriculture 2014). So, many number of palm trees is dried annually or inefficient for any reason, and their wood can be used in various industries (Sepehr, A., 2009 and Mirmahdi et al., 2010). Hence, knowing a series of physical and mechanical properties of the date palm tree has various applications that can be referred to: mechanization of palm tree operations by designing different mechanical machines, using palm timber in the railway industry, shipbuilding, furniture making, building wooden parts, industrial parts and wagons. Therefore, in the first step, there is a need for comprehensive and complete information on the characteristics and conditions of the tree (Sanadghol, R., 2000). Several studies have been carried out on the use of date palm tree pruning waste for the production of wood composite products, which can be investigated by Sepehr (2009) and (Mirmahdi et al., 2010).

According to research (Mahdavi et al., 2010), there is a significant difference between the density of the various parts of the palm tree (*Dactylifera Phoenix*) and according to this, trunk fibers and petiole fibers have the least and the highest volumetric density respectively. (Bektas et al., 2003) stated that the habitat affects the static bending, compressive strength, tensile strength and dry density of pine wood, the reason for these changes in the studied habitats depends on environmental conditions such as altitude of the sea surface and the soil of the area. Changes in wood quality with tree growth strongly depend on physical and chemical properties of soil (Rigatto et al., 2004).

In this paper, we aim to investigate some of the physical and mechanical properties of date palm stems. For example, knowing the compressive strength and tensile strength of palm timber samples, it can be designed in different industries according to the pressure applied to optimize consumption. Because wood is a heterogeneous material, the strength of wood varies in every place and depends on the properties of that point. Tensile strength of the wood in the direction of perpendicular to the fiber is less than that in the direction of the fiber. Usually the wood is rarely placed in the direction of perpendicular to the fiber under tensile load. With regard to the compressive strength of wood, this resistance increases along the warp and, as the wood becomes more compact, its resistance increases. The greatest resistance of the wood is in a dense state when the volume is about 1/3 of the initial volume. Sometimes in a dense wood, we can reach 10 times the compressive strength in the direction of perpendicular to the fiber. The resistance of the wood in the direction of the fibers is approximately equal to its resistance in two directions perpendicular to each other. Wood can be bent by bending, twisting or laminating in different shapes and associate some made parts of it in different ways (Ghofrani and Noori 2014 and Rouhani, 1988)

## MATERIALS AND METHODS

In this manuscript , in order to measure some of the physical and mechanical properties of date palm stems, 100 dry wood samples of three cultivars of the most important date cultivars of Sistan and Baluchestan (Mazafati, Rabbi and Zardan), whose ages are between 10 and 50 years old was provided from gardens of the province. The sampling was done in such a way: after cutting palm trees by the electric saw, the tree trunk was converted into smaller pieces, and the cut pieces were transported to the cutting machine by a pickup truck and cut into cubes with an approximate size of 10 cm × 10 × 10 cm. Also, a series of specimens were considered at 40 cm in length. These specimens were used for bending tests (Fig. 1).

1- Determination of moisture content:

To determine the percentage of moisture, equation (1) is used where:

$$\mathrm{MC} = \frac{\mathrm{M_1} - M_2}{M_2} \times 100 \qquad (1)$$

(Mohsenin, N. N., 1978) MC is the moisture content, $\mathrm{M_1}$ is the moist wood moisture content in grams, and $\mathrm{M_2}$ is the dry wood mass in grams, which is derived from this equation moisture content based on dry case, but if, instead of $\mathrm{M_2}$, we replace moisture of moist wood mass on the denominator, the moisture content will be achieved based on moist . First, we measured the precision of one hundredth of a gram of exactly mass of the specimens ($\mathrm{M_1}$). Then, the specimens were placed in an oven for three days at 105 ° C (AOAC, 1984), then it should be measured dry wood mass ($\mathrm{M_2}$) And the equation (1) is calculated moisture content be base of dry and humidity case for the three Mazafati cultivars, Rabbi and Zardan (Fig. 2).

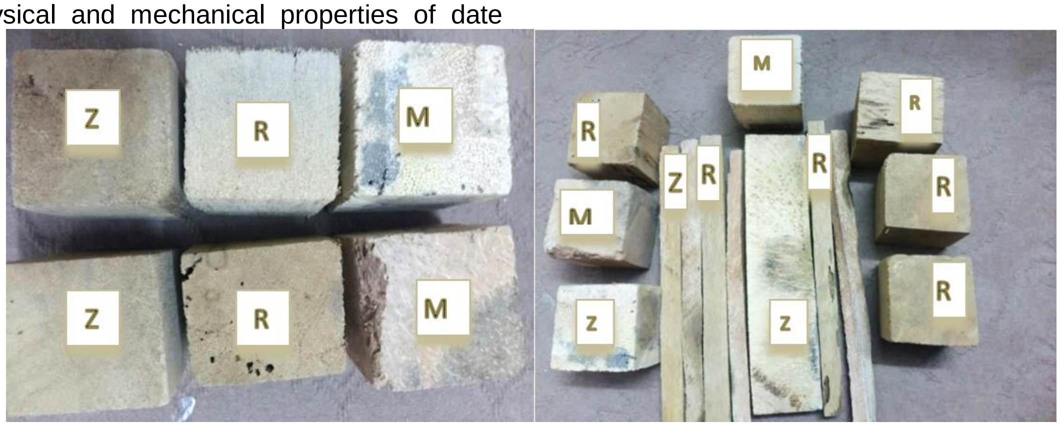


**Figure1. Prepared samples and cut from date gardens at the province**


A) B)

**Figure2. A) Primary specimens laid out in the oven (from right side it names Mazafati, Rabbi and Zardan); b) dried specimens after three days**

**2. Apparent and actual specific mass (Wood density):**

The mass ratio of the wood (M) to its volume (V) is called the specific mass of the wood indicated by (ρ) and its unit in the SI system is equal to kg / m $^3$ (Zaid, A., 2002).

$\rho = \frac{M}{V}$ (2)

In this case, if we replace the mass and volume of the wood on this equation, the specific apparent weight and, if we consider the mass and volume of the dry wood, we obtain the actual specific mass. Now, to measure the specific mass, first clean the samples so that no saw soil is left on them. Then, using a digital scale with a precision of 0.01 grams, we measure the mass of the samples (Fig. 3).

To measure the size or volume of the samples, if their dimensions are regular, by measuring the dimensions by the caliper (with a precision of 0.02 mm), the sample size can easily be obtained (Fig. 4).

But in the case of unevenly sized wood, water immersion method can be used to determine their volume. In this method, we first measure the mass of the sample with the scale (M). Then, take the sample into a container filled with water to completely immerse it. Certainly, it drains out of the water. This amount of water is actually the same amount of water displaced. This amount of water is discharged into a measuring container such as a graduated cylinders and record its volume in cm$^3$ (V), now from the division of the sample mass over the volume obtained, the specific mass (density) in g/cm$^3$ is obtained.

**3. Compressive strength:**

To measure the resistance of wood, metal or plastic against pulling, compacting, cutting, bending, etc., the pull and push device (testing) are used. The main parts of this device are: Skeleton, Electromotor, Dynamometer and Hydraulic Jack with types of spiral bars, the performance of these devices is such that the clamp according to the type of test by the force generated by the electro-motor is subjected sample by pulling, pressing, bending and cutting, and simultaneously by applying the force, Dynamometer of the machine which interfaces between the clamp and the moving part of the machine, measures the resistance of the sample. The device used here to measure resistance is the ZWICK universal Strength gauge model1496-2 D (Fig. 5).

The compressive strength is obtained by dividing the force over the cross-section (Akbarneya, AS., 2007).

**4- Bending strength:**

For bending test we have used samples of 40 cm and 5 cm × 5 cm cross section. Using a Strength gauge machine, we have placed wooden samples under bending loading; the loading is started from the point of origin and is increased gradually until the failure of the sample, simultaneously by increasing the force, loaded wood piece is bending and changed (Fig. 6).

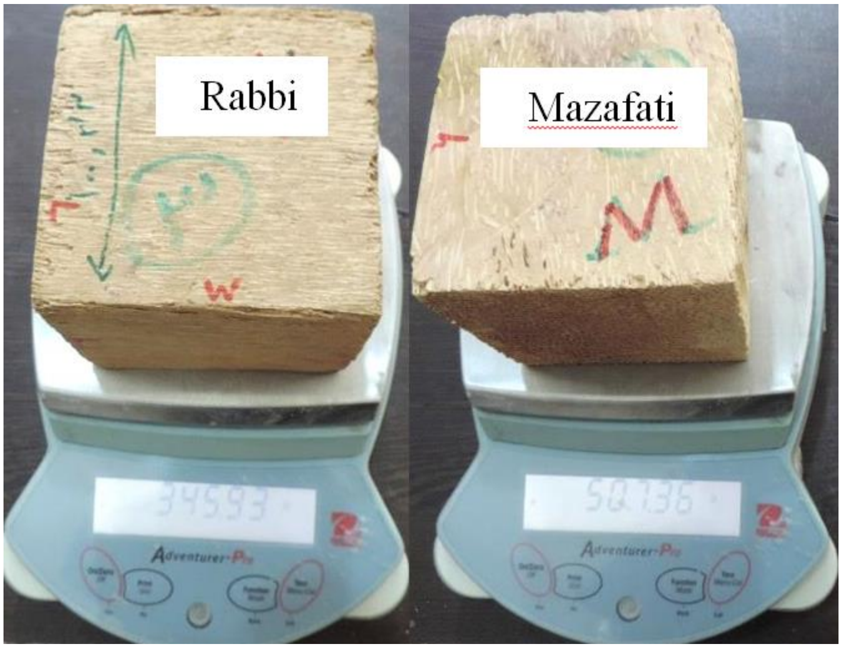


**Figure 3. Mass measurement of samples using a digital scale with a precision of 0.01 grams.**

**Figure 4. Dimensions of specimens using a caliper with an accuracy of 0.02 mm**

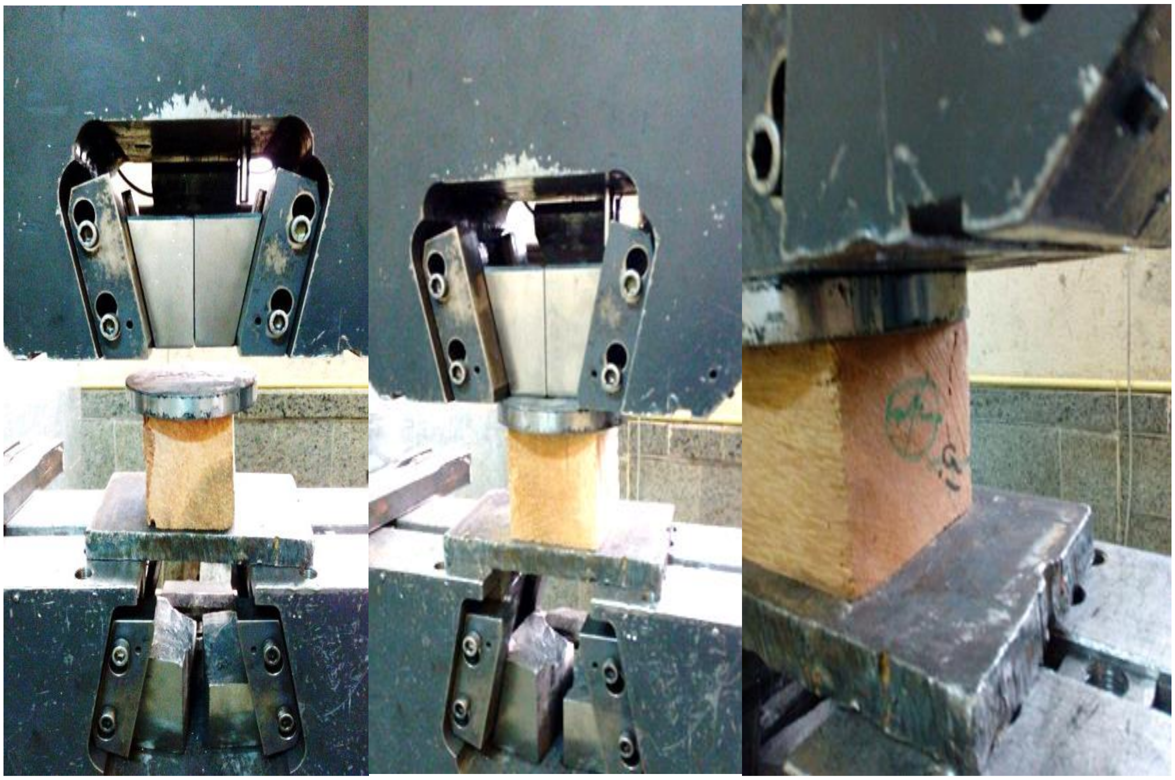

**Figure 5. Parallel and perpendicular pressure tests on the machine fiber using the ZWICK universal strength model1496-2 D in ambient conditions 23 ± 5 ℃ - Max60% W**

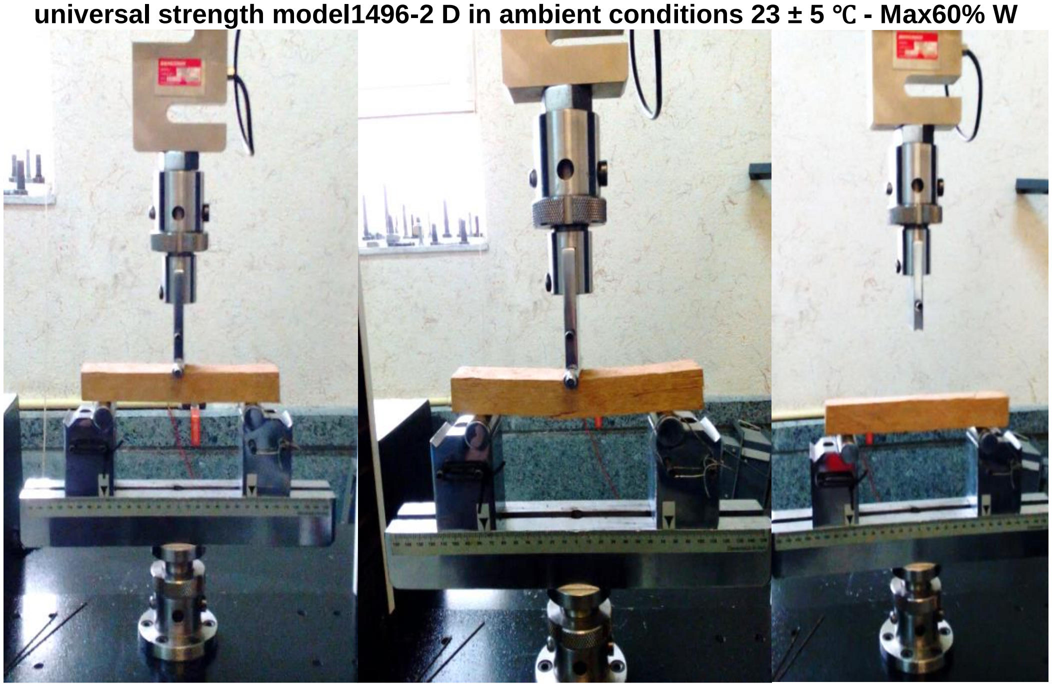

**Figure 6. Bending test, loading steps on a wood sample and its deformation.**

## RESULTS

**1- Results of moisture content on dry and wet basis:**

The results for moisture content after placement of specimens in oven for three days at 105 ° C for three Mazafati, Rabbi and Zardan cultivars are presented in Tables 1, 2 and 3.

**Table 1. Moisture content on dry and wet basis for Mazafati cultivar**

| Mazafati Cultivar | $M_1$ Mass of wet wood(gr) | $M_2$ Mass of dry wood(gr) | Moisture content on wet base(%) | Moisture content on dry base(%) |
|---|---|---|---|---|
| 1 | 287.91 | 259.01 | 10.03 | 11.15 |
| 2 | 371.92 | 337.37 | 9.28 | 10.24 |
| 3 | 507.13 | 456.71 | 9.94 | 11.03 |
| 4 | 390.13 | 355.70 | 8.94 | 9.68 |
| 5 | 318.67 | 287.18 | 9.88 | 10.96 |
| Mean | | | 9.61 | 10.61 |
| SD | | | 0.43 | 0.56 |

**Table 2. Moisture content on dry and wet basis for Rabbi Cultivar**

| Rabbi cultivar | $M_1$ Mass of wet wood(gr) | $M_2$ Mass of dry wood(gr) | Moisture content on wet base(%) | Moisture content on dry base(%) |
|---|---|---|---|---|
| 1 | 339.89 | 301.08 | 11.42 | 12.89 |
| 2 | 328.15 | 291.81 | 11.07 | 12.45 |
| 3 | 288.13 | 258.21 | 10.38 | 11.58 |
| 4 | 375.27 | 330.77 | 11.85 | 13.45 |
| 5 | 457.25 | 409.12 | 10.52 | 11.67 |
| Mean | | | 11.05 | 12.41 |
| SD | | | 0.55 | 0.71 |

**Table 3 . Moisture content on dry and wet basis for Zardan cultivar**

| Zardan cultivar | $M_1$ Mass of wet wood(gr) | $M_2$ Mass of dry wood(gr) | Moisture content on wet base(%) | Moisture content on dry base(%) |
|---|---|---|---|---|
| 1 | 302.70 | 282.80 | 7.03 | 6.57 |
| 2 | 603.89 | 567.04 | 6.10 | 6.49 |
| 3 | 455.32 | 423.17 | 7.06 | 7.59 |
| 4 | 507.13 | 477.28 | 5.88 | 6.25 |
| 5 | 342.65 | 317.41 | 7.36 | 7.95 |
| Mean | | | 6.68 | 6.97 |
| SD | | | 0.58 | 0.67 |

The results showed that the percentage based on wet kind for three Mazafati, Rabbi and Zardan cultivars was 9.61%, 11.05% and 6.68%, respectively, and based on dry one for these three varieties was 10.61%,12.41% and 6.97 percent. Also, the results indicate that the percentage of moisture based on dry and wet for Rabbi is more than ever and the lowest in Zardan (Fig. 7, 8).

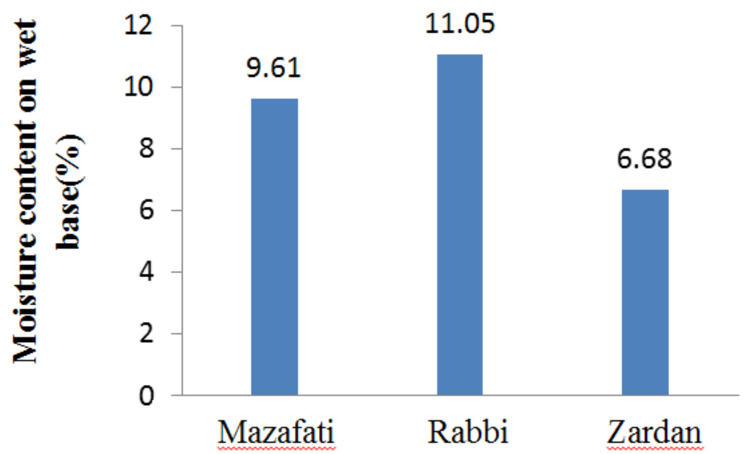


**Figure 7. Comparison of moisture conten based on wet for three varieties of Mazafati, Rabbi and Zardan**

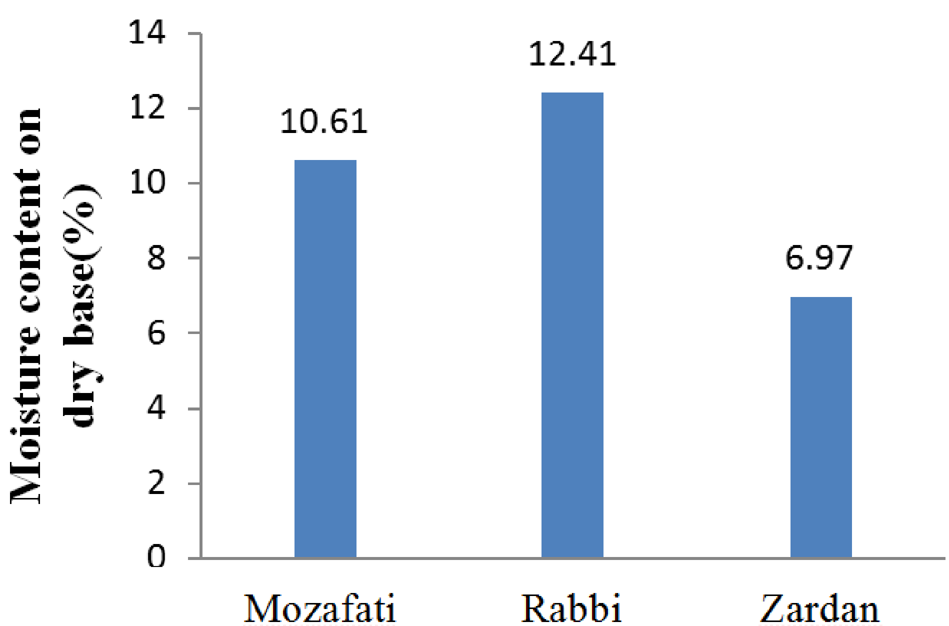


**Figure 8. Comparison of moisture content based on dry one for three varieties of Mazafati, Rabbi and Zardan.**

**Results for specific apparent and actual mass:**

The results for specific apparent and actual mass three Mazafati, Rabbi and Zardan cultivars are presented in Tables 4 to 9.

We conclude from the comparison of the average specific apparent and actual mass (density) of the wood of the three varieties dates of Mazafati, Rabbi and Zardan, that the wood of the Mazafati is heavier than and its mass is more than Rabbi. In other words, the pile of Rabbi is more than Mazafati and also the special mass for the Rabbi is more than Zardan. We also conclude that the by comparison of apparent and actual mass in general, the specific actual mass is less than spesific apparent mass, and according to Fig. 9, the greatest difference between these two specific masses is related to Rabbi and the least is related to Zardan .The reason is that the moisture content of the Rabbi is the most and the least is Zardan.

**Table 4. Results of measuring the apparent mass of Mazafati**

| Mazafati cultivar | Mass(gr) | Volume($cm^3$) | Density($\frac{gr}{cm^3}$) |
|---|---|---|---|
| 1 | 507.13 | 621 | 0.82 |
| 2 | 463.24 | 540 | 0.86 |
| 3 | 390.13 | 454.5 | 0.85 |
| 4 | 313.18 | 388 | 0.80 |
| 5 | 298.78 | 356 | 0.84 |
| Mean | | | 0.83 |
| SD | | | 0.02 |

**Table 5. Results of measuring the specific actual mass of Mazafati**

| Mazafati cultivar | Mass(gr) | Volume($cm^3$) | Density($\frac{gr}{cm^3}$) |
|---|---|---|---|
| 1 | 259.01 | 311.5 | 0.83 |
| 2 | 337.37 | 452.5 | 0.74 |
| 3 | 248.70 | 350 | 0.71 |
| 4 | 423.21 | 498 | 0.84 |
| 5 | 412.13 | 589 | 0.70 |
| Mean | | | 0.76 |
| SD | | | 0.06 |

**Table 6. Results of measuring apparent mass of Rabbi**

| Rabbi cultivar | Mass(gr) | Volume($cm^3$) | Density($\frac{gr}{cm^3}$) |
|---|---|---|---|
| 1 | 345.84 | 499 | 0.69 |
| 2 | 500.52 | 710 | 0.70 |
| 3 | 296.12 | 435.5 | 0.68 |
| 4 | 343.27 | 511.5 | 0.67 |
| 5 | 350.82 | 504 | 0.69 |
| Mean | | | 0.68 |
| SD | | | 0.01 |

Table 7. Results of measuring the specific actual mass of Rabbi

| Rabbi cultivar | Mass(gr) | Volume($cm^3$) | Density($\frac{gr}{cm^3}$) |
|---|---|---|---|
| 1 | 301.08 | 498 | 0.60 |
| 2 | 291.81 | 559.5 | 0.52 |
| 3 | 407.52 | 690 | 0.59 |
| 4 | 278.17 | 471 | 0.59 |
| 5 | 216.78 | 420.5 | 0.51 |
| Mean | | | 0.56 |
| SD | | | 0.04 |

Table 8. Results of measurement of specific apparent mass of Zardan

| Zardan cultivar | Mass(gr) | Volume($cm^3$) | Density($\frac{gr}{cm^3}$) |
|---|---|---|---|
| 1 | 508.28 | 1075 | 0.47 |
| 2 | 612.85 | 1373 | 0.45 |
| 3 | 568.75 | 1289 | 0.44 |
| 4 | 490.32 | 998 | 0.49 |
| 5 | 620.12 | 1314 | 0.47 |
| Mean | | | 0.46 |
| SD | | | 0.04 |

Table 9 . Results of measuring the specific actual mass of Zardan

| Zardan cultivar | Mass(gr) | Volume($cm^3$) | Density($\frac{gr}{cm^3}$) |
|---|---|---|---|
| 1 | 282.80 | 614.5 | 0.46 |
| 2 | 567.04 | 1339.5 | 0.42 |
| 3 | 528.15 | 1219 | 0.43 |
| 4 | 348.32 | 918 | 0.38 |
| 5 | 581.12 | 1297 | 0.44 |
| Mean | | | 0.43 |
| SD | | | 0.03 |

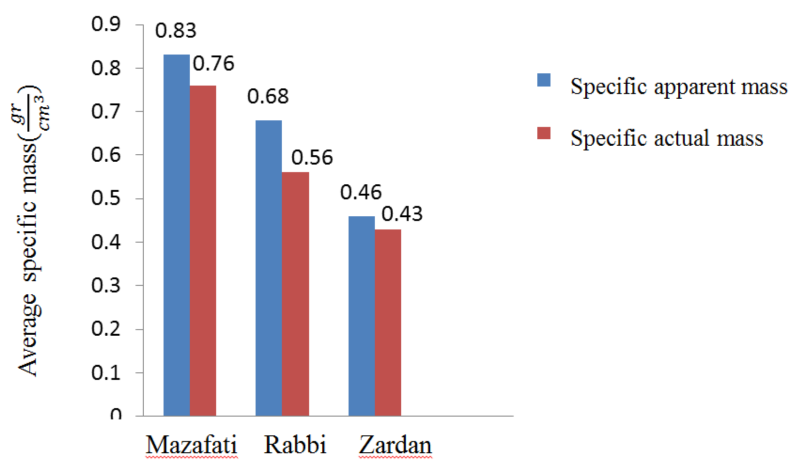


Figure 9. Comparison of the apparent mass for three cultivars: Mazafati, Rabbi and Zardan

**3- Results of pressure test:**

After placing the specimen in the pressure test machine, the values obtained for tension in the direction of the fiber and perpendicular to the fiber for the three varieties like Mazafati, Rabbi and Zardan were recorded in tables 10 to 15. The results show that the compressive strength in the direction of the fiber is far more than the compressive strength perpendicular to the fiber in general (Fig.10).

**Table 10 . Results of the pressure test in the direction of the fiber (Mazafati) under environmental conditions 23 ± 5 ℃ - max60% W by universal strength meter.**

| Mazafati cultivar | Surface($cm^2$) | Maximum force (KN) | Compressive strength(MPa) |
|---|---|---|---|
| **1** | 9.6cm × 9.8cm | 153.62 | 16.34 |
| **2** | 9.6cm ×10 cm | 142.56 | 14.85 |
| **3** | 9.8cm ×10.1cm | 148.32 | 15.13 |
| **4** | 9.7cm ×9.9cm | 150.12 | 15.63 |
| **5** | 9.5cm ×10cm | 139.87 | 14.72 |
| **Mean** | | | 15.33 |
| **SD** | | | 0.59 |

**Table 11 . Results of the pressure test in the direction of the fiber (Rabbi) under environmental conditions 23 ± 5 ℃ - max60% W by universal strength meter.**

| Rabbi cultivar | Surface($cm^2$) | Maximum force (KN) | Compressive strength(MPa) |
|---|---|---|---|
| **1** | 10. 1cm ×10 cm | 87.32 | 8.64 |
| **2** | 9.7 cm ×10.1 cm | 79.58 | 8.20 |
| **3** | 9.5 cm ×9.8cm | 90.13 | 9.69 |
| **4** | 9.8 cm ×10 cm | 75.67 | 7.72 |
| **5** | 10.1cm ×9.6 cm | 80.98 | 8.43 |
| **Mean** | | | 8.53 |
| **SD** | | | 0.65 |

**Table 12. Results of the pressure test in the direction of the fiber (Zardan) under environmental conditions 23 ± 5 ℃ - max60% W by universal strength meter.**

| Zardan cultivar | Surface($cm^2$) | Maximum force (KN) | Compressive strength(MPa) |
|---|---|---|---|
| **1** | 9.9cm ×10.1cm | 59.32 | 5.99 |
| **2** | 9.7cm ×10cm | 68.95 | 7.10 |
| **3** | 9.7cm ×9.9cm | 54.78 | 5.70 |
| **4** | 9.8cm ×10.2cm | 61.13 | 6.11 |
| **5** | 10cm ×9.8cm | 73.41 | 7.49 |
| **Mean** | | | 6.48 |
| **SD** | | | 0.69 |

**Table 13. Results of the pressure test in the direction of perpendicular to the fiber (Mazafati) under the environmental conditions of 23 ± 5 ℃ - max60% W by the universal strength meter.**

| Mazafati cultivar | Surface ($cm^2$) | Maximum force (KN) | Compressive strength(MPa) |
|---|---|---|---|
| 1 | 9.9cm ×10 cm | 136.68 | 13.8 |
| 2 | 9.6 cm ×10.1cm | 129.38 | 13.47 |
| 3 | 9.4 cm ×9.8 cm | 119.15 | 12.95 |
| 4 | 10.2 cm ×10 cm | 125.74 | 12.32 |
| 5 | 9.4 cm ×10 cm | 120.88 | 12.85 |
| Mean | | | 13.07 |
| SD | | | 0.55 |

**Table 14. Results of the pressure test in the direction of perpendicular to the fiber (Rabbi) under the environmental conditions of 23 ± 5 ℃ - max60% W by the universal strength meter.**

| Rabbi cultivar | Surface($cm^2$) | Maximum force (KN) | Compressive strength(MPa) |
|---|---|---|---|
| 1 | 10.4 cm ×10 cm | 58.83 | 5.65 |
| 2 | 9.8 cm ×10 cm | 49.97 | 5.09 |
| 3 | 10.1cm ×9.6 cm | 40.76 | 4.24 |
| 4 | 9.7cm × 10.2cm | 53.14 | 5.42 |
| 5 | 9.9 cm ×10.1 cm | 61.23 | 6.18 |
| Mean | | | 5.31 |
| SD | | | 0.64 |

**Table 15. Results of the pressure test in the direction of perpendicular to the fiber (Zardan) under the environmental conditions of 23 ± 5 ℃ - max60% W by the universal strength meter.**

| Zardan cultivar | Surface($cm^2$) | Maximum force (KN) | Compressive strength(MPa) |
|---|---|---|---|
| 1 | 10cm ×9.6 cm | 42.16 | 4.39 |
| 2 | 9.8 cm ×10.2 cm | 39.68 | 3.97 |
| 3 | 9.5 cm ×9.9 cm | 40.21 | 4.27 |
| 4 | 10.1 cm ×10 cm | 46.12 | 4.56 |
| 5 | 9.5 cm ×10 cm | 37.31 | 3.93 |
| Mean | | | 4.22 |
| SD | | | 0.24 |

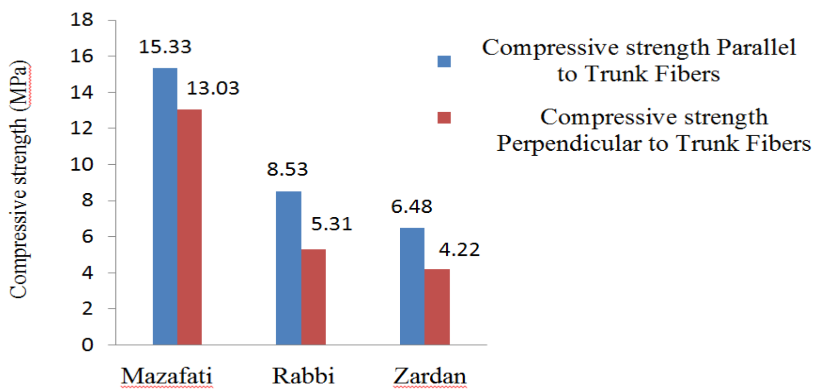


**Figure 10. Comparison of the compressive strength in the direction of the trunk fibers and perpendicular to the trunk fibers of three varieties of Mazafati, Rabbi and Zarda.**

Also, by comparing the compressive strength in the direction of date palm straw of three kinds like Mazafati, Rabbi and Zardan (Tables 1, 2 and 3), we conclude that the compressive strength of Mazafati is significantly higher than the rest. Based on the tests, the mean compressive strength in the direction of fibers for Mazafati, Rabbi and Zardan were obtained 15.33, 8.53 and 6.68 MPa respectively. By comparing the compressive strength in the direction of perpendicular to the date palm fiber of the three cultivars Mazafati, Rabbi and Zardan (Tables 4, 5 and 6), we conclude that the compressive strength in the perpendicular direction of the Mazafati was significantly higher than the rest, as well as the average compressive strength in the perpendicular direction of the fiber for Mazafati, Rabbi and Zardan cultivar was 13.07, 5.31 and 4.36 MPa respectively.

The maximum compressive strength in the direction of date palm fiber for Mazafati, Rabbi and Zardan was 16.64, 9.69 and 7.49 MPa, respectively. The maximum compressive strength in the direction of perpendicular to the date palm fiber of three cultivars of Mazafati, Rabbi and Zardan was 13.8, 18.6 and 4.56 MPa, respectively (Fig.11).

The minimum of compressive strength in the direction of date palm fiber for Mazafati, Rabbi and Zardan were found 14.72, 7.72 and 5.70 MPa, respectively.

### 4. Results of flexural strength:

After placing specimens of 40 cm in length and 5 cm × 5 cm cross section and performing a bending test, the values obtained for the three cultivars Mazafati, Rabbi and Zardan were recorded in Table 16.

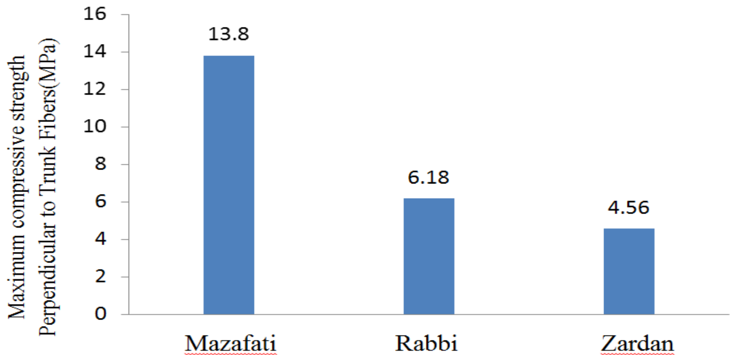


**Figure11. Comparison of the maximum compressive strength in the direction of perpendicular to the trunk fibers of the three varieties of dates like: Mazafati, Rabbi and Zardan**

**Table 16. Results of bending test (Mazafati, Rabbi and Zardan) under environmental conditions 23 ± 5 ℃ - max60% W by Universal strength meter device**

| Specimen | flexural strength for Mazafati cultivar (MPa) | flexural strength for Rabbi cultivar (MPa) | flexural strength for Zardan cultivar (MPa) |
|---|---|---|---|
| 1 | 16.21 | 12.38 | 10.18 |
| 2 | 15.78 | 11.12 | 9.82 |
| 3 | 16.48 | 11.52 | 11.122 |
| 4 | 15.97 | 12.17 | 10.87 |
| 5 | 15.64 | 10.98 | 11.25 |
| Mean | 16.02 | 11.63 | 10.65 |
| SD | | 0.55 | 0.62 |

The results show that Mazafati has the highest flexural strength and Zardan has the least flexural strength (Fig.12).

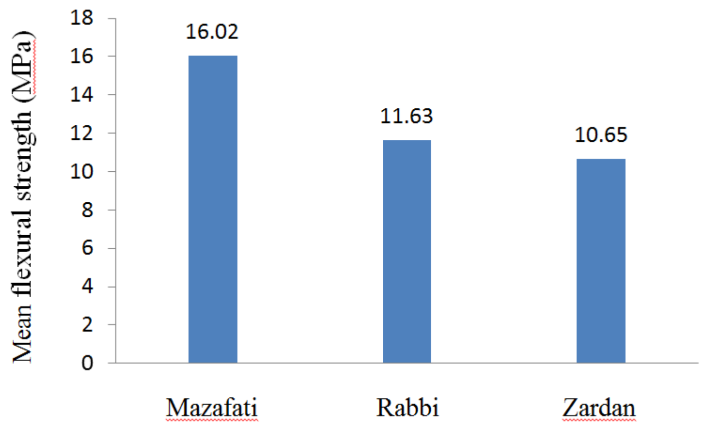


**Figure 12. Comparison of the mean flexural strength of Mazafati, Rabbi and Zardan**

## CONCLUSION

The results of the experiments show that:
the percentage of moisture content based on wet in the three varieties of dates Mazafati, Rabbi and Zardan is 9.61%, 11.05% and 6.68%, respectively.

The dry moisture content of three cultivars Mazafati, Rabbi and Zardan was 10.61%, 12.41% and 6.97 %, respectively. The results show that the percentage of wet and dry moisture in Rabbi is more than any other, and the lowest is for Zardan.

The date palm stem mass of Mazafati is much higher than Rabbi and Rabbi is more than Zardan. Based on the experiments, the specific apparent mass mean for three cultivars Mazafati, Rabbi and Zardan, in terms of gr / cm$^3$, was 0.83 gr / cm$^3$, 0.68 gr / cm$^3$, 0.46 gr / cm$^3$, and the specific actual mass was 0.76, 0.56, 0.43 gr / cm$^3$.

The largest difference between the specific apparent and actual mass is for Rabbi that is about 0.29 gr /cm$^3$ and the lowest difference is about 0.01 gr / cm $^3$ for Zardan.

By comparing the compressive strength in the direction of the date palm fiber of the three varieties of Mazafati, Rabbi and Zardan, we conclude that the compressive strength of the Mazafati was significantly higher than the rest. Based on the tests, the mean compressive strength in the direction of fibers for Mazafati, Rabbi and Zardan were obtained 15.33, 8.53 and 6.68 MPa respectively.

By comparing the compressive strength in the direction of perpendicular to the date palm fiber of the three varieties of Mazafati, Rabbi and Zardan, we conclude that the compressive strength in the perpendicular direction of the Mazafatei is significantly higher than the rest, as well as the average compressive strength in the perpendicular direction of the fiber of the Mazafati, Rabbi and Zardan were 13.07 and 13.75, and 4.22 MPa respectively.

Compressive strength maximum in the direction of perpendicular to the palm date fiber of three varieties dates like Mazafati, Rabbi and Zardan were 13.8, 6.18, and 4.56 MPa respectively.

The maximum flexural strength was related to Mazafati (16.02 MPa) and the lowest flexural strength was related to Zardan (10.65 MPa).

.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## ACKNOWLEGEMENT

The authors gratefully acknowledge the financial support for this work that was provided by Higher Educational Complex of Saravan.

## AUTHOR CONTRIBUTIONS

MP designed and wrote the manuscript. SMM collected samples and analyzed the data. All authors read and approved the final version.

## REFERENCES

Agricultural Statistics Ministry of Jihad-e-Agriculture 2014, Volume 3, Horticultural Products. available in http:// amar.maj.ir

Akbarneya, AS, 2007, Determination and comparison of compressive strength of four common olive cultivars in Iran. Doctoral dissertation, University of Tehran, Agricultural and Natural Resources Campus, Faculty of Biomaterial Engineering, Department of Mechanical Engineering, Agricultural Machinery.

AOAC. 1984. Official methods of analysis. 14th edition. Association of Official Analytical Chemists, Washington D.C.

Mirmahdi, S.M, Omidvar, A. And Madhoushi, M., 2010. Investigating the chemical and structural properties of palm leaves. Forestry and Wood Products, Faculty of Natural Resources.

Mohammad Ghofrani, Habib Noori, book of Physical and Mechanical Properties of Wood. Publishing Company of Iran Textbooks, 2014

Mohsenin, N. N. (1978). Physical properties of plant and animal materials. New York: Gordon and Breach Science Publishers.

Nourbakhsh Habibabadi, A., Abdolrahman Hosseinzadeh, A., Lotibari, A.J., Golbabaei, F., Kargarfard, A. And Hosseinkhani, H., 2001. Review of the possibility of making particleboards from lignocellulose sources in southern Iran (Potential Pellets and Palatine Waste Use in Particleboard Industry). Journal of Research in Wood and Paper Sciences of Iran, No15.

Panahi korde laghari, Muhammad, autumn 2002. Date palm (planting, having, harvesting). Jihad University of Isfahan.

Rouhani, Iraj, 1988. Date. Tehran University Publication Center. First Edition.

Sanadghol, Reza, 2000. Date production and care (translation). The author of Dr. Dawson, Agricultural Extensions Publishing.

Sepehr , A., 2009. Physical and mechanical properties of particleboard made from pruning of palm trees and pistachio rootstock with two types of MDI and UF adhesives. Graduate degree, Faculty of Natural Resources, University of Tehran. pages58.

Zaid, A., 2002. Date palm cultivation, FAO publication, No. 156, Rome.