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Experimental Study of Thermal and Mechanical Properties of Wood Boards Processed with Hard Recycled Skin of Walnut and Pistachio

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ABSTRACT: One of the main concerns of the environmental activists is felling the trees to produce wooden accessories. This action has a detrimental effect on the environment and the earth's climate, and efforts to find an alternative product seem essential. Due to the reduction of natural wood resources, along with the increase in demand for wood products, it is essential to produce recycled composites that replace wood. Since the skin structure of walnuts and pistachios can only be crushed and pulverized, they can be employed to prepare chipboard. In this experimental research, composite samples composed of the chipboard family were made using walnut and pistachio hardwood, and their physical properties were investigated. The obtained results revealed that the composites made are denser than ordinary chipboard. Despite the fact that such composites are slightly higher thermal conductivity, they have better fire resistance. The firing time for hard skin samples of walnut fruit and walnut/pistachio was 69% and 84% longer than ordinary chipboard. Due to the piece structure, the composites had a smoother cutting surface and showed a Crisp and fragile body behavior against bending. The electrical behavior of the composites was not significantly different from that of ordinary chipboard.

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1- Introduction

Cutting down trees to produce wooden artifacts is an environmental problem, and efforts to find alternative products are necessary. There are 130,000 hectares of walnut orchards in Iran, where 300,000 tons of walnuts are produced annually. Of this amount, about 66%, i.e., 200,000 tons, is the walnut fruit's green skin and hard skin, of which a very high percentage is discarded [1]. In this research, an attempt has been made to produce composite wooden structures by recycling the waste wood of fruits such as walnuts and pistachios and to compare the required physical properties such as moisture absorption, fire resistance, thermal and electrical conductivity, and bending strength with conventional samples.

2- Methodology

This research was carried out in a laboratory by making three samples of chipboard, including a) chipboard obtained from wood chips from trees, b) chipboard obtained from chopped walnut skin, c) chipboard obtained from a combination of chopped walnut and pistachio skin, which physical properties Samples (b) and (c) have been compared with sample (a), which is the test sample of the research. From each composite, 15 samples were prepared to use the new samples in different tests. To measure density, calorific value (burning heat), thermal conductivity, electrical resistance, and surface smoothness (one sample each), for tests of fire resistance, moisture absorption, bending strength (three samples each for the averaging) and a sample was also prepared as a precaution to be used if needed. The dimensions of the sample mold are 40x40x1.6 cm, and the materials are mixed and molded with a ratio of 88% by weight of wood chips and 12% by weight of glue. The dimensions of the pistachio shell from the flour state to 4.5 mm and the dimensions of the walnut shell from the flour state to 4.8 mm have been measured, and they vary within this range. The glue is urea-formaldehyde [2]. 10% of NH_4Cl adhesive weight is added as a hardener [3]. The mold is placed in the press machine for 5 minutes at a temperature of 170 degrees Celsius and a pressure of 20 kg/cm^2. Then the prepared sample is placed in the open and sunny air for a week to dry. The first chipboard sample contains ordinary wood chips, which have been used as a control sample. The wooden part of the second sample contains 44% by weight of walnut wood chips and 56% by weight of walnut bark flour. The wooden part of the third sample contains 52% of pistachio flour and wood chips and 48% of walnut flour and wood chips. Mixing fruit wood peel chips and fruitwood peel flour was done manually.

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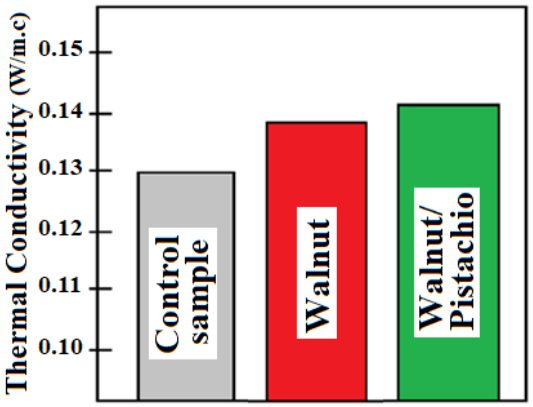

Fig. 1. Comparison of the thermal conductivity of the samples tested at 70 degrees Celsius

3- Results and Discussion

The tests carried out in this research include density measurement, calorific value (burning heat), fire resistance test, moisture absorption test, bending strength test, thermal conductivity test, electrical resistance test, and surface smoothness test after cutting. The weight of the three samples prepared in the same dimensional volumes was measured, and the density of the control sample, walnut sample, and walnut-pistachio sample was 0.37 g/cm^3, 0.74 g/cm^3, and 79/g/cm^3, respectively. 0 kg/m3 was obtained. According to the experiments, the result of the burning heat of the test samples was equal to 18.5, 17.2, and 16.4 MJ/kg for the control sample, the hard walnut shell sample, and the hard shell sample of the walnut-pistachio fruit, respectively, which shows that the use of Fruitwood can reduce the power of heat production and consequently wood fire. The fire resistance test results showed that the entire burning time of the walnut wood and walnut/pistachio wood samples was 290 seconds and 355 seconds longer than the control sample, respectively. The amount of moisture absorption is the lowest in the walnut/pistachio composite sample and is much more resistant to moisture absorption than the control sample. Reducing moisture absorption for walnut chipboard is also acceptable. The results of the bending strength tests showed that because the tissue of the walnut sample and the walnut-pistachio sample did not have a fibrous state, they act like brittle objects and are fragile against the bending force. The failure in the control sample started at 9.7 kN and completely ruptured at 11.8 kN. However, the walnut sample at 1.7 kN and the pistachio walnut sample at 7.5 kN failed at once, and instead of being shaved off, they were separated from the primary sample. Therefore, the required bending strength was not present in the walnut and walnut-pistachio samples. The results of the thermal conductivity test, according to Fig. 1, show that the thermal conductivity of the walnut/pistachio sample was the highest.

The average electrical resistance for the control, walnut, and walnut/pistachio samples showed values of 8.9, 9.3, and 9.4 Ω, respectively, and no significant difference was seen between them. Also, in cutting the surface of the samples, it was observed that walnut and walnut/pistachio samples have harder cutting and rougher edges due to the fragmented nature of the compressed particles, and the separation during cutting was accompanied by the scattering of pieces of particles, which is one of the reasons. The disadvantages of these examples are considered.

4- Conclusion

1) According to the test, the burning heat of the hard skin of the walnut-pistachio fruit was less than the walnut skin, and their burning heat was less than the normal chipboard.

2) The ignition time of the wood sample obtained from the hard shell of the walnut/pistachio fruit and the walnut fruit's hardwood was 84% and 69% longer than the ordinary chipboard, respectively.

3) The results showed that the resistance of walnut/pistachio wood as well as walnut wood is higher than normal chipboard against moisture absorption, and they have fewer structural changes than normal chipboard.

4) The results showed that the walnut and the walnut/pistachio sample acted like a brittle object against the bending force and are brittle, which may be partially solved by preheating with steam and softening the structure of walnut and pistachio wood.

5) The thermal conductivity of the walnut/pistachio sample is slightly higher than the walnut sample, and the thermal conductivity of the two is slightly higher than the normal chipboard. However, their structure is such that fire development in them is associated with a more significant delay.

6) There was no apparent difference in electrical resistance between the samples.

7) After cross-cutting the sample and visual observation of the cut surface, it was observed that the cut area in the walnut/pistachio sample and the walnut sample with separation into pieces are more uneven than the typical chipboard sample.

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