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## ORIGINAL ARTICLE

# Effect of Fiber Type and Content on the Physical and Mechanical Properties of Four Types of Natural Fiber-High Density Polyethylene Composites against the Fungus

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**ABSTRACT**
*In order to evaluate the effect of fiber type and content on the Physical and Mechanical properties of natural fiber-high density polyethylene (HDPE) composites against the fungus Coriolus versicolor, composites containing kenaf, rice hulls, newsprint and wood floor as the reinforcement at 25% and 50% by weight maple wood flour and 1% and 2% compatibilizer (Maleic anhydride polyethylene (MAPE), respectively, were sampled. Physical and mechanical properties of all specimens including water absorption, flexural modulus, flexural strength, impact strength and hardness were determined prior to and after incubation with the fungus for 14 weeks at 25 °C and 75% relative humidity. Results indicated that samples containing 50% natural fiber were more susceptible to fungal decay as compared with those with 25% fiber. Rice hulls proved to be the most vulnerable natural fibers as nearly all mechanical properties of rice hulls composites significantly declined after contamination by the fungus.*
***Keywords:*** *Natural Fiber-Composites-Polyethylene- Incubation- Coriolus versicolor*

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## INTRODUCTION

Natural fiber plastic composites have experienced soaring increase in the consumption for various applications, especially decking and outdoor structures. Lower density, lower cost, relative no abrasiveness, and little environmental concerns are among the main advantages of using natural fibers in composites when compared with their synthetic counterparts [1, 2]. However, one of the greatest concerns regarding this new class of materials is their susceptibility to living organisms such as wood decaying fungi and termites, which may attack them under favorable conditions and eventually lead to their degradation and loss of mechanical properties. Therefore, the study of the effects of fungal decay on the properties of such composites calls for immediate attention. Rainbow fungus (*Coriolus versicolor*) is one of the most common and dangerous saprophytes that attacks hardwoods all around the world. The effect of this fungus is quite considerable on solid wood regardless of its species [3, 4].

## EXPERIMENTAL MATERIALS

1-Wood-based composites (Nine series of specimens were prepared according to Table 1).
2- Culture medium (Malt Extract Agar).
3- Purified Rainbow Fungus (*Coriolus veversicolor).*

### Methods

### Composite specimen preparation

The composite boards were sampled according to Tabel 1 with three repetitions.

### Preparation of culture medium

The purified fungus was transferred to Petri dishes containing malt extract agar under sterile hood using sterile pincers. Then, the Petri dishes were kept in the laboratory at 25 °C for 1 week so that culture medium was fully covered by the fungus.

### Contamination of composite specimens with the purified fungus

The Kolle dishes containing composite samples were then transferred to incubator to control relative humidity and temperature for 4 weeks at 25°C and 75% RH.
Measuring of physical and mechanical properties of the composites after contamination with fugues in comparison to those of control specimens
Three-point flexural tests were done based on ASTM D-790 specification, method I.
**Unnotched Izod Impact tests** were performed according to ASTM D-256 specification.
**Hardness tests** were carried out based on ASTM D-758 specification using a Shore D hardness tester.
**Water Absorption** were performed according to ASTM D-570 specification. The water absorption values were calculated using the oven dry weight and wet weight using Eq. 1. (1)

$$\text{Water absorption (\%)} = \frac{\text{wet weight - dry weight}}{\text{dry weight}} \times 100$$

## RESULTS AND DISCUSSION

The results indicated that the greatest loss of flexural strength and the flexural modulus loss and the impact strength loss is occurred in the case of RH-50-2 specimens due to the chemical composition of rice hulls with low lignin content and high percentage of inorganic materials(Fig1,2). The highest hardness loss is occurred in the NP-50-2 specimens that can be attributed to the lignifications of fibers during paper making process. Figure 2 shows that the impact strength of wood based composites decreases as fiber content increases, and prior to contamination with Rainbow fungus, the impact strength of the specimens containing higher fiber is lower in comparison to that of specimens with lower fiber content.

**Table1. Composition of the evaluated formulation (4)**

| Code | MAPE Content% | HDPE Content% | Fiber Content% | Fibers | N |
|---|---|---|---|---|---|
| **RH-25-1** | **1** | **74** | **25** | **RH** | **1** |
| **RH-50-2** | **2** | **48** | **50** | **RH** | **2** |
| **KF-25-1** | **1** | **74** | **25** | **KF** | **3** |
| **KF-50-2** | **2** | **48** | **50** | **KF** | **4** |
| **NP-25-1** | **1** | **74** | **25** | **NP** | **5** |
| **NP-50-2** | **2** | **48** | **50** | **NP** | **6** |
| **WF-25-1** | **1** | **74** | **25** | **WF** | **7** |
| **WF-50-2** | **2** | **48** | **50** | **WF** | **8** |
| **PE-100** | **0** | **100** | **-** | **PE** | **9** |

RH - Rice hulls NP- newsprint KF- Hemp fibers
WF-Wood maple flour PE- High-density polyethylene

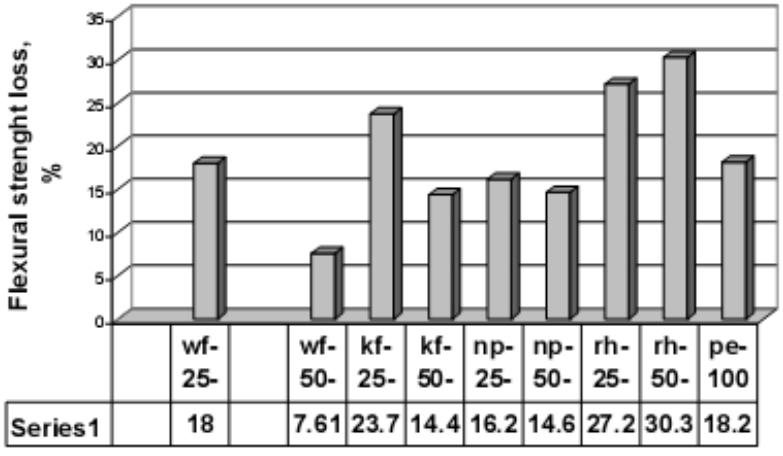


Figure 1. Flexural strength loss in composites after contamination with rainbow fungus for 14 Weeks.

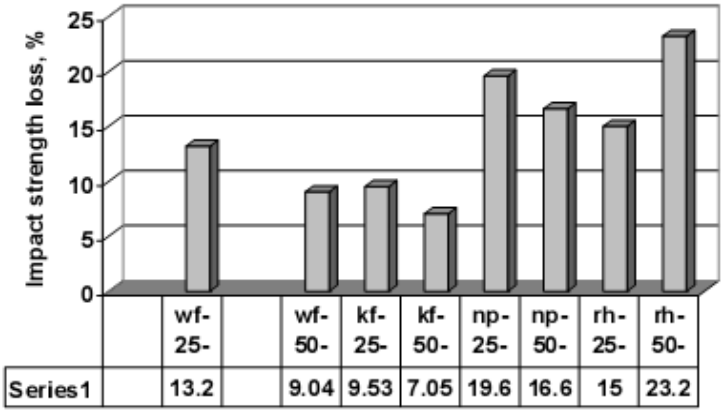


Figure 2. Impact strength loss in composites after contamination with rainbow fungus for 14 weeks.

## CONCLUSION

Having higher lignin and cellulose content as a result of higher fiber, the composites containing 50% fiber are more susceptible to Rainbow fungus in comparison to those containing 25% fiber. Among all types of composites, the specimens containing 50 % rice hulls are more susceptible to the fungus, and all mechanical properties of the specimens except hardness are significantly decreased. In other words, rice hull is more susceptible to the fungus than the other fibers. This is explained by the fact that rice hulls contain low amount of lignin and high proportion of inorganic materials. As a whole, the results of the present study show that all mechanical properties of the composites containing 25% maple wood flour (WF-25-1) with compatibilizer except flexural strength are superior than those of other composite types.

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