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The Effect of MAPE and PEG Compatibilizer physical and mechanical properties of Wheat straw-Low density polyethylene Biocomposite

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Introduction : Over the past 30 years with population growth, plastics have played an important role in the people's lives and its consumption is increasing. However, the most important problem of synthetic packaging materials is their total non-biodegradability that is causing environmental pollution.

In recent years, concerns about the environmental problems caused by packaging materials and plastic derived from petroleum products as well as consumer demand for qualitative food products, hascaused researchers to find alternative materials with high biodegradability, which has led to the development of biocomposites.

Therefore,wheat straw-low density polyethylene composite (as a renewable material) was prepared in order to reduce the consumption of plastics in the packaging industry and the effect of two different compatibilizers, maleic anhydride polyethylene (MAPE) and polyethylene glycol (PEG) on mechanical and physical properties of obtained biocomposites was investigated.

Materials and Methods: Wheat straw (WS) was first dried at 30 ℃ for 24 hours. It was then manually cut to 2-3 cmpieces manually and then was milled. The ground wheat straw was screened through 40 mesh sieve. After that, all materials including WS flour, LDPE, MAPE , and PEG were blended to prepare the different biocomposites by twin-screw extruder. The extruded materials were cut into smaller pieces proper for the next processing step by grinder.grinded. The obtained granules were then placed in the injection-molded machineto create the test samples.so combinations, respectively, were considered : WS, LDPE, MAPE (sample 1) WS, LDPE, PEG (sample 2) , LDPE (sample 3) and WS, LDPE (sample 4).

Water absorption test was performed according to ASTM D 570-98 in order to study the amount of moisture absorbed by the composite samples. The samples were weighed for 9 weeks, the first time, after 24 hours, then once a week. For this purpose, samples were taken out of the water then surface moisture was dried, finally moisture absorption was calculated according to weight changes.

Biodegradability test was carried out based on soil burial method for 4 monthsaccording to ASTM 6400-99. In this test, samples were taken out of the soil and washed by water every 15 days. They were thenplaced in an oven at 100℃ for 24 hours. Subsequently, samples were weighed by a digital scale with an accuracy of 0.1 mg.The amount of degradation was calculated by controlling weight changes over the time.

The tensile strength, the maximum amount of force taken by a material before its failure was performed to evaluate the effect of natural fiber on the composite characteristics. It is measured with units (Pa) and (Mpa). The test was done according to ASTM D 638-08by Instron machine.

The flexural strength of a material is defined as its ability to resist deformation under load. The test was done according to ASTM D790-10by Instron machine.It wasalso measured with units (Pa) and (Mpa).

Result and Discussion: The results showed that the use of PEG compare with MAPE greatly increased the rate of water absorption and biodegradation of samples. It may be because of PEG's hydrophilic property that cannot act well as MAPE. Therefore, it creates an improper and weak interface adhesion between the wheat straw and polyethylene, resulting in gaps and cracks in this section. Thus, water absorption is higher in composites containing PEG. These factors also caused faster degradation in samples containing PEG. However, the use of MAPE in the composites improved surface adhesion between the wheat straw fiber and polyethylene, and therefore less water absorption and degradationwas observed.

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In terms of mechanical properties samples containing MAPE had greater tensile and flexural strength compared to samples containing the PEG.Because MAPE creates an ester bond in composite, which improves the interfaceadhesion of wheat straw particles and polyethylene, but when the PEG used, adhesion between wheat straw particles and polyethylene is not enough to increase the efficiency of stress transfer from the matrix to the fibers.

Since almost all properties of materials are associated with each other, it cannot be introduce a combination that all properties is best. Therefore, when high biodegradability is desired, sample containing PEG is suitable but in terms of mechanical properties and resistance to water absorption, the sample containing MAPE is best combination.

Keywords: Water Absorption, Biodegradability, Compatibilizers, Biocomposite, Mechanical properties