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Effect of Treatment on Mechanical Properties *of Irvengia gabonensis* Shell Fiber Reinforced Polypropylene Composite

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Abstract: *The problems associated with the use of synthetic fibers cannot be over emphasized; they are costly and non-environmentally friendly. Hence, there is need to explore other alternatives. An Irvengia gabonensis fiber and shell particles reinforced polypropylene composite was produced and its mechanical properties were studied. Effect of treatment of the fiber and the shell particles on the mechanical properties of the composite has also been studied. The study revealed that the treatment of the fiber and shell particles can influence the mechanical properties of the composite.*

Key words: *Polypropylene, Irvengia gabonensis,Shell, Particles*

Introduction

Fiber is a class of material that is a continuous filament or discrete elongated pieces, similar to the lengths of thread. They can be spun into filaments, rope or string. The two main sources of natural fibers are plants and animals. The main component of animal-based fibers is protein (Shubhra *et al.*, 2010): examples include; wool, silk, alpaca, angora, and so on. The major components of plant fibers are cellulose microfibrils, lignin and hemicelluloses: examples include; cotton, jute, flax, ramie, sisal, hemp, and so on. Fiber reinforced composite materials are classified as important engineering materials. This class of materials offers outstanding mechanical properties and their composite are easy to fabricate. The plant fiber has been in used as reinforcement in composite materials since 3,000 years ago; the Egyptians used straw to reinforced clay to build walls. However, the current application of plant fiber in composites is mainly non-structural components with a random fiber orientation used by the automotive and building industry (Broge 2000; Clemons 2000). Composites made from synthetic fibers such as glass, graphite and aramid are commonly used in wide range of applications ranging from aerospace structure to automotive parts and from building materials to sporting goods (Arib *et al.*, 2006). FRPCs find applications in construction industries, decking, window and door frames, sports equipment such as bicycle frames, baseball bats, exercise equipment, and so on sports equipment such as bicycle frames, baseball bats, exercise equipment, and so on. They are also suited for many automotive applications (Bledzki and Gassan 1999). For construction purposes jute PP composite can play an important role all over the world. Jute polypropylene composite can be used for interior design, particle board, ceiling, and construction purposes. Instead of importing particle board and cement we can use jute Polypropylene composite (Siddika *et al.,* 2014). However, the development of natural fiber reinforced composites becomes an attractive research area and a possible substitute for synthetic fiber composites due to the non-recyclability; high density and health hazards associated with composites reinforced with synthetic fibers such as glass, carbon and aramid fibers (Corrales *et al*., 2007). Natural fiber is a long filament which can be obtained from plant, mineral or animal sources. Among the above three classification, plant fiber represent more than 95% of the total volume of natural fibers worldwide. As a result, the term "natural fiber" usually refers to the natural fibers from plant origin. The performance of fiber reinforced polymer composite (FRPCs) depends on the constituent materials. The length of reinforcing fiber and fiber content are the two important factors affecting the mechanical properties of a fiber-reinforced composite. A lot of research has been done on plant fibers (such as flax, hemp, jute, bamboo, coir, etc.) as reinforcement for composite materials due to their renewable nature and good mechanical properties. These properties depend to larger extent on the structure and chemical composition of the fiber. However, environmental conditions and age are factors that affect the structure and composition of plant fiber and their mechanical properties. The performances of Short-Carbon-Fiber-Reinforced Polypropylene Composite for Car Bonnet composites were compared to the standard steel material applied and were found to be a viable replacement option. Nadir *et al*. (2011) found in their study that the optimal composite panel formulation for automotive interior applications was obtained from a mixture of 60 wt % the coir fiber, 37 wt % the PP powder, and 3 wt % the MAPP. Doan *et al*. (2006) investigated the effect of maleic anhydride grafted PP (MAPP) coupling agents on the properties of jute fiber/PP composites. They observed that addition of 2wt% MAPP to PP matrices improved the adhesion strength with jute fibers and the mechanical properties of composites. Girone´ s *et al*. (2007) studied the PP-based composites, reinforced with surface modified pine fibers. Tensile modulus increased only by 12% after incorporation of untreated fibers to PP matrix. Despite the fact that a lot has been done on natural fiber reinforced polymer composites, there remains a wide gap to be filled in that area. This is owing to fact that there are abundant natural fibers that are not exploited as reinforcement for polymer composite. Among the natural fiber that are not exploited or less exploited is *Irvengia gabonensis* shell fiber. This plant can be found abundantly in every part Nigeria and in fact other countries in Africa but use of the waste from the fruit of this plant is scanty. Therefore, there is need to further device way of using this agricultural waste in way that is beneficial to the human kind.

Methodology

Materials/Equipment

Materials

- *Irvengia gabonensis* fruit remnants collected from various gardens in Maiduguri and Jere local government areas of Borno state
- Polypropylene
- Sodium hydroxide (NaOH) solution
- Distilled water

Equipments

- Universal Testing Machine
- pressure compression molding machine of 30tonn capacity
- Two roll mill
- An impact testing machine
- Digital weighing balance
- Thermometers
- Specimen mould
- Razor blade

Methodology

Method used involved the extraction of the fiber and shell from *Irvengia gabonensis* fruit. This was followed by washing the fiber and shell with water and then dried them. The fibers and the shell prepared thus were further treated with NaoH. The fiber, shell and the Polypropylene formulations was done in such a way that the proportion of fiber and shell particles loading to Polypropylene was continuously varied by 10wt% up to 40wt%/60wt fiber/shell and Polypropylene. The formulation was mixed using two roll mill one after the other, at 40 rpm processing speed and 190^{o}c. The blends were then used to make test sample plates through compression molding. The specimens were produced according to ASTM standards, as this determines the dimensions of the specimens.

Result and discussion

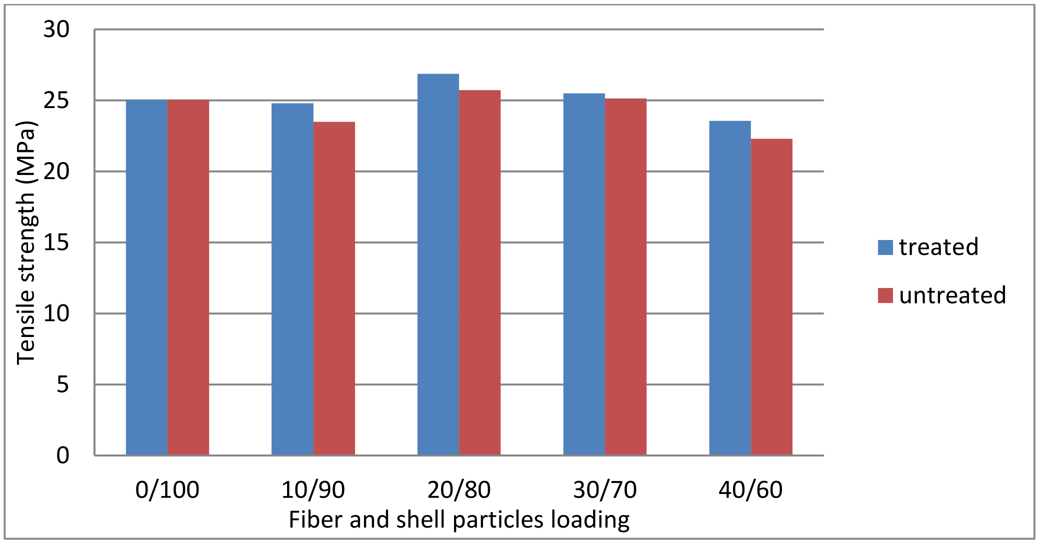

Figure1: Tensile strengths of treated and untreated Bush-mango fiber and shell particles reinforced Polypropylene composites at different fiber and shell particles loading

Figure1 shows the tensile strengths of treated and untreated *Irvengia gabonensis* fiber and shell particles reinforced polypropylene composites at four different fiber and shell particles loadings. At 10wt% fiber and shell particles loading, there was drop in tensile strengths. This is due to poor concentration of the fiber and shell particles in the composite but as the loading increased to 20wt%, increase in the tensile strength was observed in both composites. However, the tensile strength of the composite made from treated fiber and shell particles were higher than those made from the untreated fiber and shell particles.

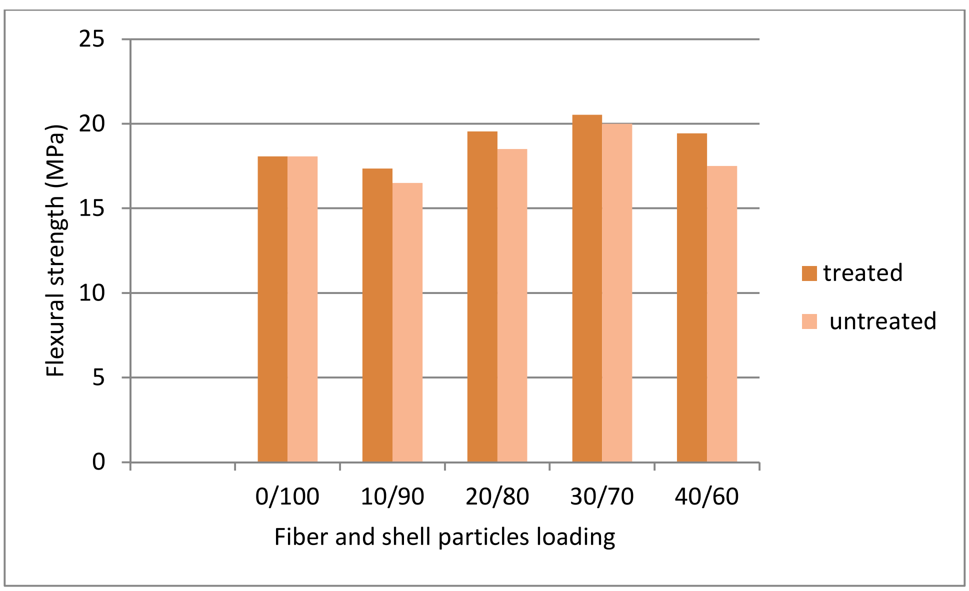

Figure 2: flexural strengths of treated and untreated Bush-mango fiber and shell particles reinforced Polypropylene composites

It can be seen from figure 2 that the maximum flexural strength was recorded at 30wt % fiber and shell particles loading in both cases. Increase in flexural strength was also observed at 20wt % but is not as high as that of 30wt % fiber and shell particles loading. It can also be seen that the flexural strength of the treated fiber and shell particles reinforced composite in all the four different loadings were higher than those of the untreated fiber and shell particles reinforced composite.

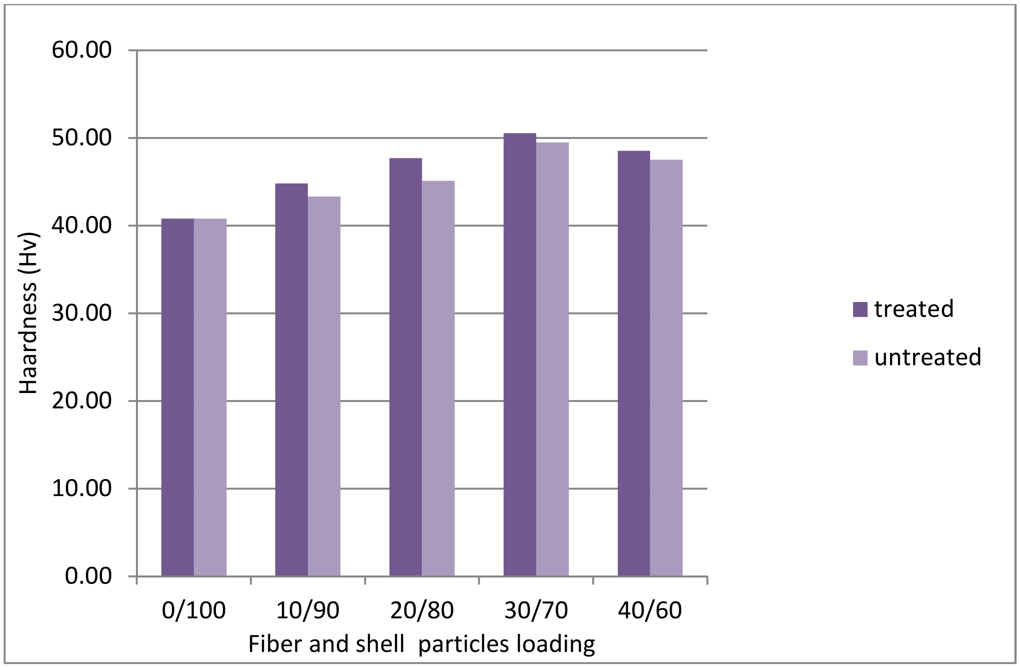

Figure 3: Vickers's hardness of treated and untreated Bush-mango fiber and shell particles reinforced Polypropylene composites

Figure 3 shows hardness of the two composites, the hardness increases as the fiber and shell particles loading increases up to 30wt % loading beyond which the property declined. It can be observed that the incorporation of fiber and the shell particles led to increase in the hardness of the composites in all the formulations. The effect of treatment of the *Irvengia gabonensis* fiber and shell particles has also been seen.

Conclusion

The fiber and shell particles of ***Irvengia gabonensis*** can be used as reinforcement for polypropylene matrix to produce natural fiber reinforced composite. It was also found that the NaOH treatment and varying the proportion of fiber and shell particles to Polypropylene can influence the mechanical properties of the composite. The composite produced can be used for interior applications such as partition wall.

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