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Effect of Kapok and Oil Polypropylene

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Abstract: Non-abrasive, lightweight, controllable, non-toxic, affordable, biodegradable natural fibers. Natural fibers are less helpful since they are hydrophobic and absorb water poorly. This research seeks to establish the mechanical and physical properties of kapok- and oil-reinforced polypropylene composites. Determine the composite's strength and weight. 0%, 5%, 7%, and 10% kapok and oil are mixed with polypropylene resins and pulverized. Injection molding creates a tensile and impact pattern from the pellet. Tensile, impact, density, thermal, and SEM testing are then performed. This test shows that fiber modification improves the composite's physical attributes, but it has low tensile and impact strength. Tests include tensile, impact, density, heat, and SEM. This experiment shows that fiber modification enhances the composite's physical attributes, yet testing indicated low tensile and impact strength.

Keywords: Kapok 1, Natural 2, Kapok Polypropylene Composite

1. Introduction

As global technology becomes more sustainable, the need to replace natural fiber in composites grows. Natural fibers are lightweight, controllable, non-toxic, cheap, biodegradable, and non-abrasive. Hydrophobic properties and low water resistance make natural fibers less practical. This study examines the mechanical and physical properties of composites incorporating kapok fiber and oil- reinforced polypropylene. In addition, determine the strength and weight of natural fiber polyester composite. 0%, 5%, 7%, and 10% kapok and oil are combined with polypropylene resins and crushed.After the pellet is injected, a tensile and impact sample is created. After tensile, impact, density, thermal, and SEM tests, the sample is analyzed. This experiment shows that fibers modification enhances the composite's physical properties, however mechanical tests indicated low tensile and impact strengths.

1.1 Introduction

Recently, there's been a rise in demand for economical, innovative materials. Growing

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environmental concerns, international treaties, and changes in governmental regulations have increased interest in natural fibers in a variety of industries during the past decade. Due to their high tensile properties, strength, impact strength, and elasticity, natural fiber reinforcements are preferable than synthetic fiber reinforcements. They're cheaper, lighter, denser, stronger, renewable, non- corrosive, and easier to create than traditional materials. These properties and biodegradability have led to their broad application in automotive, aerospace, and transportation.

1.2 Physical and mechanical properties

Physical and mechanical qualities of polypropylene present problems in numerous applications. Its fatigue resistance and flexibility make it a versatile material. Due to its dynamic crosslinking, polypropylene (PP) has poor strength resistance at low temperatures and with notches. Overloading polypropylene that exceeds its capacity and degrades its properties is considered defective.

This research obtained two objectives which investigate the effect of kapok and oil on the mechanical and physical properties of polypropylene and evaluate the strength properties and lightweight of natural fiber polyester composite

This project aims to develop a kapok and polypropylene composite with high-strength properties. Composite mixtures undergo tensile, thermal, and other tests. It's important to study the plastic composite's qualities because it can be used in industries. This experimental study proves that plastic composite compositions have good mechanical and physical properties.

2. Materials and Methods

Experiments included all preparation materials and actual sample testing. Building materials are polypropylene resins and kapok. These tests aim to examine the properties of polypropylene-kapok composites and determine the best materials for industrial applications. The research method can be broken down into several steps. This ensures the analysis is completed smoothly and systematically to meet its aim.

2.1 Materials

When preparing a specimen, five compositions are available. Each mixture has the same ratio but varying kapok and oil percentages. Every blend is 30 gr. Table 1 shows the proportions for combining polypropylene resins, kapok, and oil.

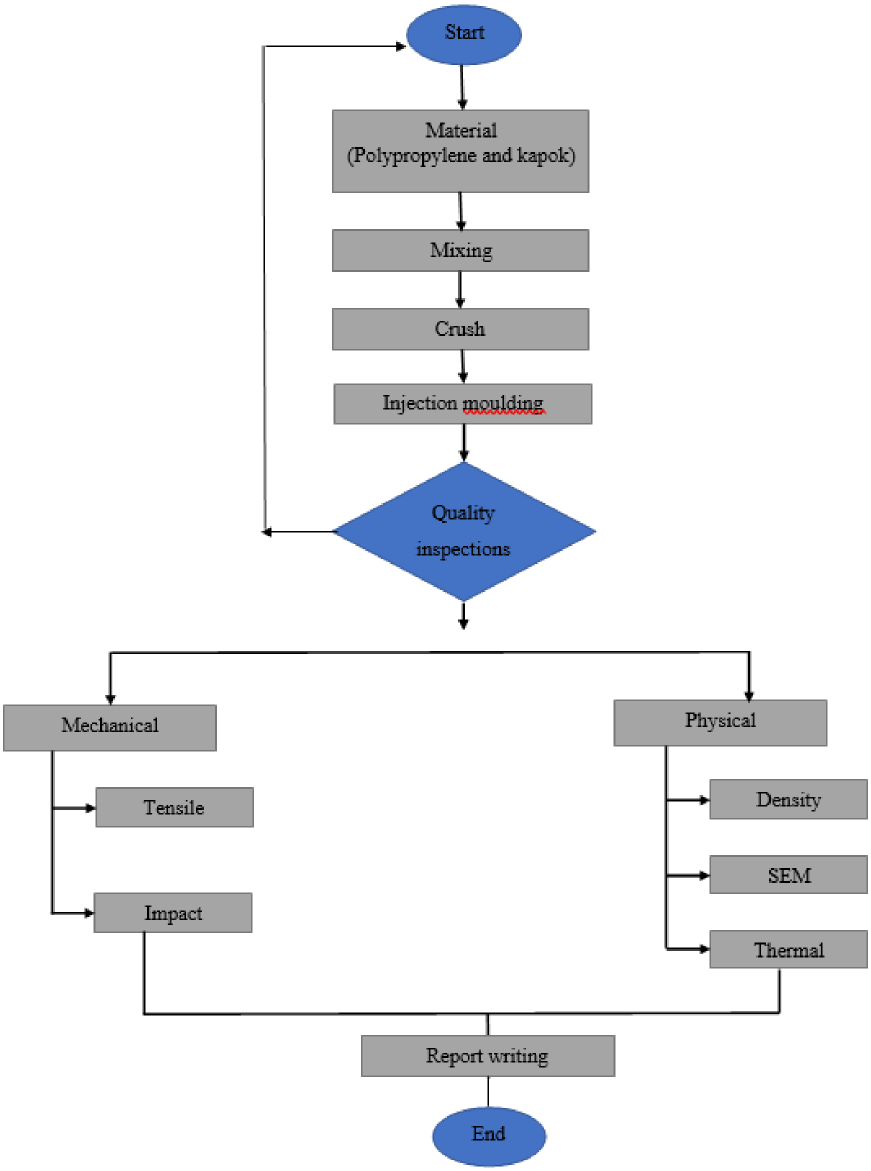
Table 1: The proportion of mixture and kapok

Specimen	Percentage (%)	Kapok(g)	Oil(g)	PP(g)
1	0	0	0	30
2	1	0.15	0.15	29.7
3	5	0.75	0.75	28.5
4	7	1.05	1.05	27.9
5	10	1.5	1.5	27

For injection molding, each ratio needs 150g. Injection molding requires five of each 30 g mixture.

2.2 Methods

The research method can be broken down into several steps. This ensures the analysis is executed smoothly and systematically to satisfy its aim. The flowchart below shows the procedure.



3. Results and Discussion

The mechanical and physical test results for the composite are discussed. Each test will be taken down and analyzed in-depth to find the composite plastic's properties. The composite was mixed using a Brabender mixer, and samples were injection molded for mechanical and physical testing.

3.1 Impact test

Charpy impact test results are in joules (J). Each sample's cross-sectional impact area is $800 mm^2$.

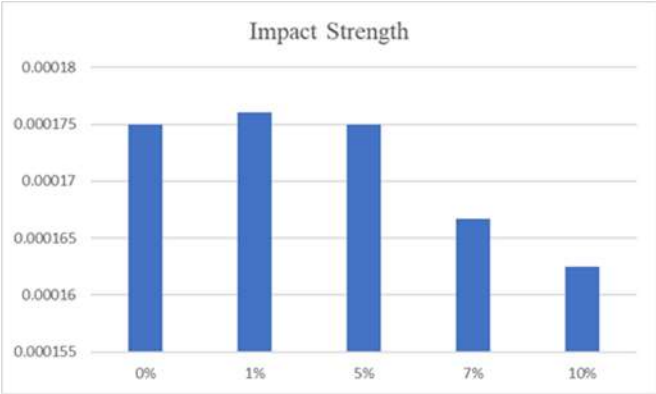


Figure 1: Graph young modulus at break and maximum point

The figure 1 shows that the composite's impact strength diminishes with more kapok and oil in the polypropylene matrix. The maximum impact strength was 0.000176j for 1% kapok and oil.Samples with the most kapok and oil had the lowest impact strength, 0.0001625j. This sample is the weakest. Overall, the investigation shows that kapok and oil reduce the composite's impact strength. Poor adhesion of kapok, oil, and PP causes this. High-velocity impact loads exceed the fiber strength of kapok and polypropylene composites. This produces brittle fracture in kapok and PP composites.

3.2 Density

According to table 2, the density of the PP composite sample decreases proportionally with the amount of kapok and oil.

Table 2: Density of kapok and oil mixture in polypropylene

Sample	Percentage of kapok and oil	Density (g/ m^3)
1	0%	0.889
2	1%	0.845
3	5%	0.755
4	7%	0.740
5	10%	0.736

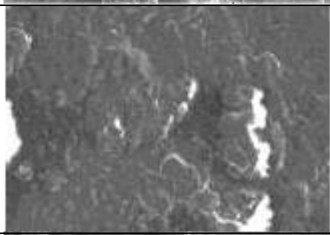
The plastic composite mixture specimen floated in water during testing, according to findings and observations. Sample 1, which has no kapok or oil, has the highest density of 0.889 g/m3, while sample 5, which contains 10% kapok and oil, has the lowest density of 0.736 g/m3.

Consequently, kapok is hydrophobic and buoyant. If so, this could float to the liquid's surface. Adding kapok to a plastic composite makes it lighter and less dense than polypropylene alone.Cooking oil's lower density than water makes the substance lighter. Using kapok and oil in the composite mixture creates a lighter plastic composite. Using kapok and oil in the composite mixture creates a lighter plastic composite.

3.3 Scanning Electron Microscopy Analysis (SEM)

SEM samples reveal varying amounts of kapok and oil. Micrograms were imaged at different magnifications and locations showing various magnifications of SEM images of kapok and oil composite fracture surfaces.

Table 3: The images of SEM on different percentages of kapok and oil

Sample percentage (%)	Magnifications (umm)	
	100	500
0%		
1%		
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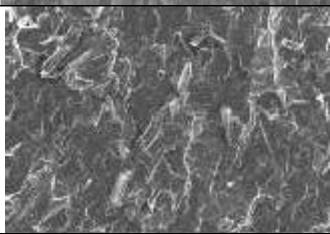
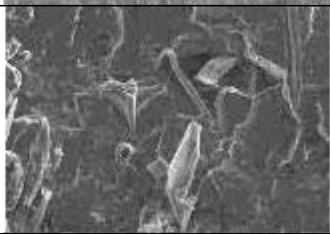
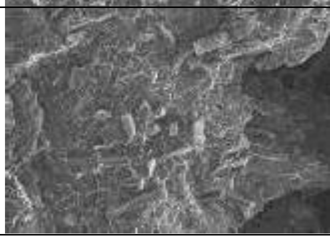
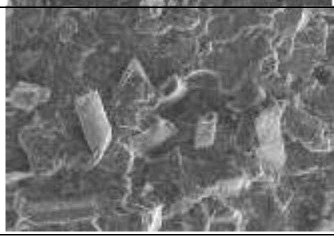
7%		
10%		

Increasing kapok reduces kapok-polypropylene interaction. Kapok increases this impact. Table 3 shows that the sample with the most kapok and oil had the weakest interaction. In the 1% sample, no kapok was seen, indicating a positive interaction. Unmodified kapok exhibits weak interfacial adhesion, according to Hussiensyah and Chun's research. Image-shown PP and kapok interaction lessens. Weak adhesions have decreased the mechanical characteristics' strength, as their interactions are vital for withstanding testing stress.

3.3 Thermogravimetry (TGA)

In this test, the PP composite combined with kapok and oil will be examined. Real peak, onset point,offset point, energy consumed, and mass loss are included. For the crushed mixture's bulk, a little sample is taken. It will then undergo a TGA analysis. A TGA has a thermal balance and a 300°C, 10°C/min furnace.

Table 4: The images of SEM on different percentages of kapok and oil

kapok and oil content	Onset (°C)	Offset (°C)	Real peak (°C)	Energy (mJ/mg)	Mass loss(mg)
0%	143.2	186.5	165.8	-57.5	0.91
1%	138.9	181.4	164.9	-58.15	0.765
5%	143.2	174.9	161.7	-41.4	0.747
7%	142.9	174.9	162.5	-56.0	0.666
10%	144.3	169.0	158.2	-41.4	0.621

Clearly, each sample has a different peak. The higher the kapok and oil concentration in the PP composite, the lower the melting point. PP with no changes had the highest real peak temperature of 165.80°C, and PP with 10% kapok and oil had the lowest at 158°C. This result matches the energy needed to reverse the exothermic reaction. Less energy is needed for more kapok and oil. This is because kapok fiber has a large amount of cellulose (62.87%) and hemicellulose (26.32%). Reduced crystalline cellulose impairs the thermal properties of kapok composites, according to Mwaikamboo's study. Due to hemicellulose molecules' low heat resistance in amorphous cellulose. Adding kapok reduces the composite's thermal resistance, according to tests.

3.3 Tensile test

ISO 527 tensile test was performed on a universal testing machine. Five samples are provided for eachkapok and oil percentage and the oil itself. Compare only the top three averages. According to the obtained results, the majority of the samples were damaged somewhere in the center of the gauge line.

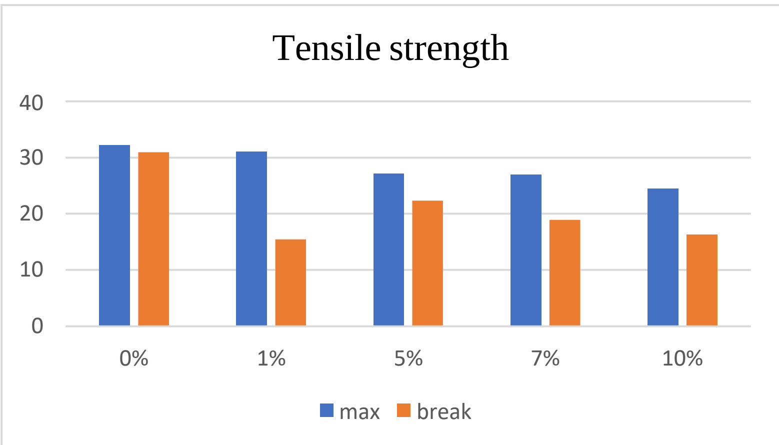


Figure 2: Graph tensile strength at break and maximum point

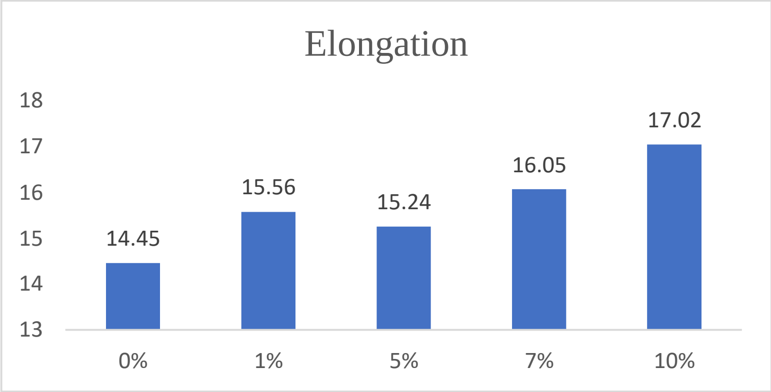


Figure 3: Graph Elongation at break

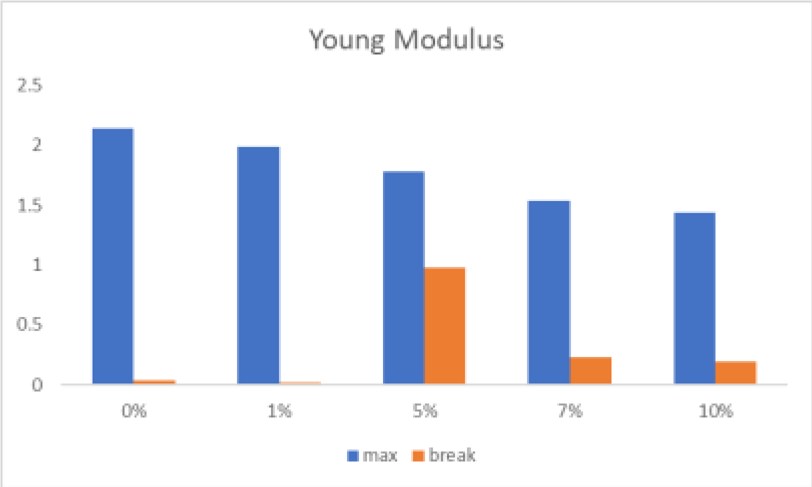


Figure 4: Graph young modulus at break and maximum point

Polypropylene with a 1% combination of oil and kapok have the highest young modulus at the maximum breaking point. Elongation is the percentage of a material's intact length at which it fractures. The most elongated polypropylene composite is 10%. Composites contain cellulose, hemicellulose, and lignin, which link and degrade natural fiber. A fiber's tensile strength and stiffness are affected by its cellulose content and microfibril orientation. Due of kapok's high crystallinity orientation index (COI), the fiber tends to be rigid and may cause tensile issues. Mechanical loads can weaken kapok fibers. The spiral lines in kapok fiber's cell wall indicate axial weak links, resulting in varying mechanical properties. Kapok reduces polypropylene's tensile strength. Results may matchthe prior report. The mechanical properties of Kapok must be improved.

4. Conclusion

Physical and mechanical tests failed to demonstrate that adding kapok improves the composite material. The density test demonstrated that the composite sample is less dense..

Other testing, such as thermal, tensile, and impact, indicated some inconsistencies. The inclusion of elemental elements in kapok reduces the composite's strength and must be treated before testing. Hydrophilic cellulose affects the matrix-kapok fibre interface because the matrix is hydrophobic.

In summary, there are some recommendations and proposals to improve the experiment and future research.

- Use different kapok PP mixing ratios in a larger study to see a clearer difference in testing results.
- Machine brabender mixing time has been increased from 15 to 25 minutes to ensure composite mixing.
- Test samples with impact. Future analysis could yield several outcomes.
- Treat kapok before mixing for better results.
- Fourier-transform infrared spectroscopy (FTIR) to improve composite test findings.

Acknowledgement

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