Mechanical Properties of Chemically Treated Banana and Ramie Fibre Reinforced Polypropylene Composites

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Abstract. Present research focuses on finding better fibre reinforcement cheap and eco-friendly polypropylene composite. Mechanical Properties increased with increase in fibre loading and sodium carbonate Treatment. Banana and Ramie Fibres were chosen as reinforcement. The compression moulding technique was used to prepare the composite material. Fibre loading was varied at 0, 5 and 10 % volume. Both raw Banana and Ramie Fibre was chemically treated with 5 wt% sodium carbonate and composites were also prepared with 0, 5 and 10% volume treated ramie and banana fibre. Analysis of prepared composites was subsequently conducted using Mechanical Tensile, flexural, hardness tests and. 10% fibre reinforced composite provided the best set of mechanical properties. It can be concluded after chemical treatment the mechanical treatment got enhanced.

Keywords: Banana Fibers, Ramie Fibers, Chemical Treatment, Polypropylene Composites.

1. Introduction

The replacement of polymeric fibers for existing synthetic fibers is in high demand owing to its applications. The main reason for this is due to easy availability, geographical location and easy accessibility. The processing of these fibers is also easy. Many of the modern technologies especially aerospace and transportation require the materials having the properties combination of metal, ceramics and polymer. The natural fibers are used as an key ingredient in various applications such as automobile, household and aero space [1-6]. Polymer matrix composites reinforced by various synthetic fibres fulfill the most of the demands. However their high processing cost, less availability, non-biodegradability and health hazardous are the main matter of concern. One of the important characteristics of natural fibers are inexpensive and will control the environmental side affects [7]. Out od the fibers such a glass,synthetic and plant based fibers. The utilization of plant based fibers increased day by day due to its ease extraction and availability.Chemical analysis is one of he important parameters of analysing the quality of fibers. The cellulose and amorphous contents are vital in examining the mechanical and morphological properties of the fibers. The various amorphous contents such as hemicellulose,lignin are removed to improve the mechanical performance. The strength is also
dependent on the crystalline (cellulose) and amorphous (hemicellulose, lignin, pectin) contents which are directly dependent on the environmental conditions and location in which the plant is present. The chemical treatment becomes effective only when the optimal chemical concentration and soaking time are followed, else there will be drastic removal of chemical constituents from the composition of fibre thereby leading to poor results. There are many chemical treatments that are widely used namely alkalization, benzoylation, peroxide, stearic acid, HCl, stearic acid, silane treatment, etc for surface modification of the fibres. Banana and Ramie fibre reinforced polypropylene composites were prepared using hand layup technique. After obtaining they were treated by sodium carbonate (Na$_2$CO$_3$). In order to increase the adhesion between polypropylene and fibre. Mechanical testing and thermal characterization of prepared composites were conducted. Finally the effect of fibre type, fibre loading and chemical treatment on mechanical and thermal properties was evaluated.

2. Preparation of Composites

The banana and ramie fibers were prepared by hand layup techniques. The fibers were retted and developed as a composite. Initially the fibers were collected from local market in Chennai and soaked in water for 24 hours. Later the chemical treatment was performed. Sodium carbonate treatment was carried out for the retted fibers. The same step by step procedure was carried out which was done in our previous literature[8-10].

3. Results and Discussion

3.1 Banana Fibre and Ramie Fibre

The surface modification of Banana Fibre and Ramie Fibre was done by using Na$_2$CO$_3$. It seems that both banana and ramie fibres after modifications had some smooth surfaces with less impurities and wax or fatty layer. The Treatment of fibres decreased the spiral and increased the orientation of fibres. Because of roughening, bonding between fibre and matrix increased after chemical treatment. The mechanical properties of the fibres were increased and the details were mentioned below. The retted fibers images were shown below.

![Figure1: Images of Retted Fibers](image.png)

3.2 Tensile Properties
Tensile strength of polypropylene and various prepared composites is shown in Figure 1. Tensile strength of prepared composites was higher than that of pure polypropylene. Previous research also confirms the same trend [11]. Tensile strength also increased with increase in fibre loading. As we know that both the banana and hemp fibres are having good tensile strength when it is mixed with polypropylene. The higher fibre ratio banana and hemp fibres increased the fibre tensile strength. On comparing these two fibres banana had good results than the hemp because of its better reinforcements when compared to hemp fibre. The Tensile Strength of the banana fibres were increased from 23.5% to 34.56% for 5 and 10 weight percentages. Similarly on the other hand tensile strength of the ramie fibres was in the range of 31.23% which is lower than that of the banana fibres. This is mainly due to the presence of uniform cross section of banana fibre to the aspect ratio. Banana fibre has more uniform cross section and greater aspect ratio as compared to Ramie fibres. Treatment of banana fibres with Na$_2$CO$_3$ gave the better results compared to ramie. This is mainly due to the distribute load of the matrix in a better way. It also restricts the growth and formation of crack which will restricts the failure better. The outcome of this results in a banana fibre with increased tensile strength. The same trend was also found in the work carried out before [12-14].

![Tensile Strength of Developed Composites](image)

3.3 Flexural Properties

The Flexural Strength of the developed composites is analysed and the details are given below. Flexural strength varies with the similar fashion as tensile strength. Flexural strength of polypropylene and various prepared composites is shown in Figure 2. Flexural strength increased with an increase in fibre loading, which is in agreement with the findings of other researchers [15]. Incorporation of 10% banana fibre in polypropylene increased flexural strength by 7.23 percentages and banana fibres with 10 and 15 weight percentages increased the flexural strength by 25.3% and 32.7%. The favourable entanglement of the polymer chain with the filler may be the reason of improvement. 5% Na$_2$CO$_3$ treatment increased flexural strength of both jute and banana fibre reinforced polypropylene composites as compared to raw jute and banana fibre reinforced polypropylene composites. Previous research confirmed this phenomenon due to surface modification of the fibre [18-20]. There is not much deviation between the banana and ramie fibres this may be attributed to better adhesion between the fibres and the matrix [16-18].
3.4 Hardness

Hardness of polypropylene and various prepared composites is shown in Figure 4. Shorehardness of pure polypropylene was found to be 94.6. Due to fibre addition and fibre treatment shore hardness increased significantly [19]. Hardness of 5% Na$_2$CO$_3$ treated banana fibre was 95.2 whereas 10% had some increase in the value of 97.45. Increasing the fibre loading increased the hardness of the composites. On the other hand, 5% of ramie had hardness of 93.25 whereas hardness 10% of ramie fibres was 96.8. This scenario could be linked to the better adhesion of the matrix to the fibre. The addition of natural fibre to a polymer matrix has been seen to reduce flexibility by retarding the molecular movement of the polypropylene matrix. Fibre addition also decreases the flexibility of the matrix and increases hardness [20-21].
4. Conclusion

In present research, banana fibre and Ramie Fibres were prepared composites were prepared with 0, 5 and 10 volume% fibre lading. Both Ramie and banana fibre was treated with 5% Na$_2$CO$_3$ solution. The various properties such as tensile, Flexural and hardness got enhanced by using Chemical treatments 10% banana fibre reinforced composite provided the best set of mechanical properties. Depending on these experimental results, one can easily produce low cost environment friendly high strength polymer matrix composites for automobile industry as well as domestic purpose. In future it can be utilised for automobile applications.

5. References

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