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STUDIES ON POLYPROPYLENE BIO COMPOSITE WITH CORN HUSK WASTE

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ABSTRACT

The interest in the utilization of bio-fillers in thermoplastics has increased recently, mainly due to the need in overcoming the environmental problems caused by the agricultural by products. Polypropylene is an outstanding commercially available important thermoplastic material with wide range of applications in various fields because of its balanced chemical and mechanical properties. The incorporation of the bio fillers at compositions ranging from 10-30% was carried out by melt compounding in segmented single screw extruder and then injection molded into standard test samples. Mechanical, thermal and morphological characteristics of the blend systems were studied to evaluate the effect of filler content on polypropylene. It has been found that while there is a slight decrease in tensile strength and elongation, the tensile modulus was found to be increased with the filler content. There is a good dispersion of both the filler materials in PP matrix. The thermal stability of the PP matrix is found to be increased significantly by the presence of filler.

Key words: Thermoplastic composites, Mechanical properties, Corn husk.

INTRODUCTION

In the recent years, polymeric composite materials are being used in variety of applications such as automotive, sporting goods, marine, electrical, industrial, construction, household applications etc. Polymeric composites have high strength and stiffness, light weight and high corrosion resistance. Most of the composites available on the market today are produced with a high durability to ensure product longevity. Unfortunately, in order to make these products, companies have traditionally used non-biodegradable fibers, made from non-renewable resources. The most important disadvantage of such composite materials is the problem of disposal after end use. This raised the attention of people for the use of natural, sustainable, biodegradable and renewable resources. In modern production environment, there is a great demand for every material to be recyclable or degradable. Natural fiber composites (NFCs), are composite materials i.e., formed by a matrix (resin) and a reinforcement (fiber), in which the fibers are natural i.e., mainly formed by cellulose and therefore originating from plants. Some of these fibers can be hemp, jute, flax, sisal, banana, kapok etc. NFCs markets are significantly on the rise, mainly because of the recycling and environmental necessities. Lignocelluloses are the primary building block of plant cell walls. Polypropylene is an outstanding commercially important thermoplastic material with wide range of **applications in** various fields because of its balanced chemical and mechanical properties. (1-6)

SCOPE OF THE WORK:

The present work is aimed at the following objective.
To use non edible corn husk as bio fillers at different composition in polypropylene to get bio composite.
To determine its effect on mechanical, thermal and morphological properties of polypropylene bio-composites. Therefore the experiments are classified into two parts.

POLYPROPYLENE AND CONHUSK COMPOSITES:

Corn husk is one of the major agro-waste products, which contains cellulose 40%, hemicelluloses 45%, ligin7%, protein 2%, ash 3%, by weight. Studies are ongoing to fine ways to use lingo cellulosic materials include making films by pre-treatment. Beneficial effects of pretreatment of lingo cellulosic material have been recognized for a long time. Cornhusk which has become environmentally problematic waste is now being converted into useful industrial materials. (6-11)

EXPERIMENTAL

Materials

The reinforcing filler used was corn husk (CH) obtained, Reliance fresh supermarket, Chennai. This corn husks were ground and then sieved to obtain corn husk flour with size of≤75µm.Polypropylene co-polymer grade (Repol B650) was supplied by Reliance company, with melt flow index of 65g/10min (230^0 C/2.16 Kg) and a density of 0.9g/cm3. . Reagent grade Toluene used for wet ability is obtained from RR Scientific chemicals, Maduravoyal, Chennai.

Preparation of composites:

The corn husks were washed thoroughly with water to remove the adhered contaminants, and dried in an air oven at 100^0 C for 24 hours. The dried corn husks ere ground and then sieved to obtain corn husks flour with size of≤75µm, Polypropylene is mixed with various weight ratios of corn husks (10%, 20%, 30%) and toluene (solvent), introduced into a laboratory single screw extruder maintained at maximum temperature of 210^0 C for 25 min at a roller speed of 200rpm. The extrudate was cooled and passed through a pelletiser and cut into granules and dried.

RESULTS AND DISCUSSION

Mechanical properties:

Tensile properties of polypropylene, polypropylene –corn husk composite at various corn husk composition (10%, 20% and 30%) are shown in the table 1.

Table 1: Tensile properties of polypropylene and polypropylene-corn husk composite

Sample	Tensile strength (Mpa)	Elongation at Break (%)	Tensile Modulus
Polypropylene (PP)	35.566	4.167	1968.367
Corn Husk(10%)+ PP	30.570	2.692	2117.124
Corn Husk(20%)+ PP	27.951	2.051	2298.705
Corn Husk(30%)+ PP	28.107	2.628	2179.503

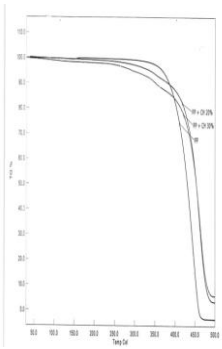
Comparison of tensile strength, elongation at break and tensile modulus of polypropylene, corn husk-polypropylene composite at various corn husk compositions (10%, 20% and 30%).When compared to virgin polypropylene, tensile strength of the corn husk – polypropylene biocomposite has decreased, whereas the tensile strength has increased from 27.951 to 30.570 with decrease in corn husk percentage (20% to 10%) with polypropylene The elongation at break has decreased drastically from virgin polypropylene to corn-husk –polypropylene biocomposite, whereas it has been increased from 2.051 to 2.692 with decrease in corn husk percentage (20% to 10%) with polypropylene. The modulus has increased drastically from virgin polypropylene (1968.367) to corn husk-polypropylene biocomposite (2298.705) and the modulus has also increased with increase in corn husk percentage (10% to 20%) with polypropylene.

Thermal properties

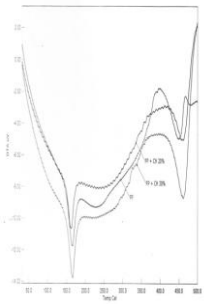
Thermo gravimetric analysis (TGA) result s: The thermal stability of polypropylene (PP), corn husk polypropylene (CH+PP) biocomposite for 20% and 30% corn husk percentages are studied and compared using thermo gravimetric analysis (TGA). The degradation temperature (on set and 50% decomposition) of polypropylene (PP), corn husk-polypropylene (CH+PP) biocomposite for 20% and 30% corn husk percentage are shown in the following table. Thermal stability of 20% and 30% corn husk-polypropylene (CH+PP) biocomposite were found to be higher when compared to virgin polypropylene. Degradation temperature (at 50% and at above 90% decomposition) of polypropylene and polypropylene-corn husk composite.

Table 2: Melting temperature and thermal stability values of polypropylene –corn husk composites.

Sample	Polypropylene	PP + CH (20%)	PP + CH (30%)
Degradation at 50% decomposition	430.7	453.2	452.8
Degradation at 90% decomposition	458.4	493.7	494.5



Comparison of TGA curves of corn-husk Composites

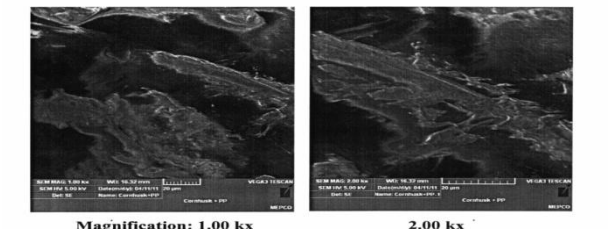


Comparison of DTA curves of corn-husk Composites

Morphological characteristic

The surface morphology of corn husk- polypropylene bio composite was studied using scanning electron microscope (SEM). The SEM images of 30% corn husk-polypropylene bio composites are shown in the following figures. From the image the compatibility between the corn husk powder and virgin polypropylene were found to be fairly good.

SEM micrographs of (a) PPCH (10 %), (b) PPCH (30 %)



Magnification: 1.00 kx 2.00 kx

CONCLUSIONS:

The results of studies are discussed as follows. The tensile strength has reduced for the bio composites when compared to virgin polypropylene. Although there was also a reduction in strength as the corn husk percentage increases, the modulus shows a drastic increase in percentage of corn husk powder. The morphology of the bio composites was characterized using Scanning Electron Microscope (SEM) from which fairly good compatibility between polypropylene and corn husk powder was observed. The thermal stability was characterized using Thermo Gravimetric Analysis (TGA). The thermal stability was also found to be high for the bio composites when compare to virgin polypropylene. The melting temperature and thermal degradation temperature were examined using Differential Thermal Analysis (DTA). The melting temperature and the thermal stability were found to be higher in composites when compared to the virgin polypropylene.

Hence, this bio composite can be used in low end applications, where strength is not considered to that extent such as in boards, baskets, household utensils, etc.

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