Evaluation of Hazelnut Shells in Polypropylene Based Polymer Composite Production

Karim Yildirim
Centre of Ataturk Anorganic Chemistry, Turkey
Email : K.Yildirim99@yahoo.com

Abstract

Natural fibers have been commonly utilized to reinforced materials for many years. Recently due to advantages of natural fibers such as low cost, high physical and mechanical resistance are produced plastic-composite materials by mixing various proportions. In addition, plastic composites are used natural fibers include agricultural wastes (wheat straw, rice straw, hemp fiber, shells of various dry fruits, etc.). In this study, polymer composites were manufactured using waste nutshell flour as filler and polypropylene (PP) as polymer matrix. The nutshell-PP composites were manufactured via extrusion and compression methods. The final product tested to determine their tensile, flexural, impact strength properties as well as some physical features such as thickness swelling and water absorptions. The best results were obtained composites containing 30% nutshell flour. In addition, composites which were produced nutshell provided the values of ASTM D6662 standard. The data collected in our country which waste a large portion of nutshell allows for the evaluation of the production polymer composites. The incorporation of nutshell flour feasible to produce plastic composites when appropriate formulations were used. As a result hazelnut shell which was considered agricultural waste can be utilized in polymer composite production.

Keywords: *Nutshell, Polymer Composites, Physical and Mechanical Properties.*

A. INTRODUCTION

Forest resources in the world and in our country show a decrease due to the increase in population and consumption. Therefore, conscious use of raw materials, recycling of used materials and finding new raw material resources have become important. It is clear that the imbalance between the demand for wood raw material and the available supply will be inevitable. Therefore, it becomes imperative to use alternative fibers from agricultural and other sources instead of wood fibers. In our country, the parts remaining after the agricultural harvest are either mixed back into the soil or destroyed by burning. Demands to use these wastes in different ways are increasing day by day (Cooper & Balatinecz 1999; Rowel 2001; Mengeloğlu & Alma 2002).

For a cleaner and more livable environment, the amount of waste should be reduced. Realizing this can only be achieved by reducing waste generation, increasing recycling and reuse, natural it will be possible with the rational use of resources. In this context, the "3R" rule is tried to be implemented in many countries. The aim is to generate less waste. reduce the raw material used (Reduce) is the reuse of a product (Reuse) and the realization of the recycling of a material (Karakus, 2008; Hill 2010).

One of the areas where agricultural fiber wastes can be used most effectively is the plastic industry. In addition, the increase in the prices of plastic-based products in the last few years has made it necessary to add cost-effective additive fibers to plastics. a very small amount of it, and has about three million tons of plastic waste in Turkey is involved in recycling (Rowell 1995; MENGELOĞLU 2006). In our land, approximately 60 million agricultural waste and 5 million m3 forest industry.

There is waste generated (Mengeloğlu et al. 2002; Kurt et al. 2002; Korucu & Mengeloğlu, 2007). As shown clearly exists a large amount of incinerated waste material in Turkey or the majority thereof are disposed by being left in landfills (Karakus, 2008).

Our country provides 65-70% of world hazelnut production with an annual production of 350-600 thousand tons. Most of this amount is sold without shells and the shell part is generally used as fuel, and a very insignificant part is known to be powdered and used as food additives in some foodstuffs such as chocolate (Yıldırım 2007). Composite production is the most common modification process performed on polymer materials (Yıldırım 2007). Materials that are formed by the combination of two or more materials and often have better properties than the material that make them up are defined as composites (Simonsen 1995; Mengeloğlu et al. 2002).

In this study, the mechanical and physical properties of the material produced by producing polymer-composite using pure polypropylene plastic and hazelnut shell flour were investigated.

B. METHOD

Hazelnut shell used as filler for polymer composite production was obtained from Giresun province and pure Polypropylene (PP) in granular form was used as polymer. After the hazelnut shells were completely dried in the drying oven, they were turned into flour with the help of a Willey mill. Because the dimensions of the filling material affect the performance of the produced material, the fillers in the form of flour were classified and divided into 40-60-80-100 mesh groups with the help of a shaker sieve. Since the lignocellulosic filler used in this study is suitable for industrial production, it was taken from the part above the 40 mesh screen.

After this application, it was extruded from a Rondol brand single screw extruder with a temperature of 170 to 190 ° C and screw speed of 40 rpm and turned into pellets. Pellets were turned into sheets in a hot press heated up to 180 ° C.

features are made in accordance with American Standards (ASTM). Bending strength and tensile strength tests were performed using Zwick/Roell Z010 Universal testing machine. Flexural strength according to ASTM D 790, tensile strength according to ASTM D 638 standards.

Figure 1: Extruder Machine

Impact resistance tests were carried out with Zwick / Roell HIT 5.5P machine and according to ASTM D 256 standard. Before the impact resistance test, the Polytest RayRan device was used to notch the samples. Water uptake rate and thickness increases are determined according to ASTM D 1037 and EN 317 standards.

C. RESULT AND DISCUSSION

SPSS analysis was performed after the mechanical test values of the plates formed by adhering to the production recipe. First, homogeneity tests were carried out, then analysis of variance (ANOVA) was performed at the confidence interval of $P < 0.05$ to examine the effect of the hazelnut shell flour ratio on the mechanical properties, multiple comparisons were applied to determine from which sample mean the differences between the groups originated, and the DUNCAN test was applied for this purpose. Statistical analysis results and averages are given in Table 1.

Table 1 Mechanical Test Values and Applied ANOVA and DUNCAN Test Results

Composite groups (% rate)	Do not Pull resistance (MPa)	In pull elasticity (MPa)	Bending resistance (MPa)	In bending elasticity (MPa)	Coup resistance (J / m)
PP (%0)	23,87(1,44)A	384,52(29,85)A	32,22(3,01)A	968,72(87,95)A	26,74(5,12) D
FK 1(%30)	8,34(0,77)B	248,26(31,62)B	16,55(1,02)B	847,24(82,87)B	72,90(12,89) A
FK2 (%40)	6,69(0,32)C	240,05(14,57)B	13,86(0,48)C	822,73(65,44)B	58,21(6,43) B
FK3 (%50)	5,66(0,33)D	233,22(11,27)B	11,96(1,80)D	745,90(94,88)C	43,55(6,96) C

Values in parentheses indicate standard deviation values. Letters in the same column indicate differences according to Duncan test ($P < 0.05$)

As a result of the mechanical tests, it was observed that as the ratio of lignocellulosic substance increased, the resistance values decreased. As the use of lignocellulosic substances increases, the rate of plastic decreases, and in this case, it is seen that it causes a decrease in resistance values (Mengeloğlu & Karakuş 2008). However, it was seen that the tensile, bending and impact resistance values in a study using wheat straw were close to the tensile, bending and impact resistance values of the FK1 sample.

Average values of long-term dehydration and thickness increase rates of plates produced with lignocellulosic material and thermoplastic polymer are given in Tables 3 and 4. Measurements were carried out periodically for each plate type at 2, 24 and 48 hours, 1 and 4 weeks.

Table 2 Thickness Increase Rates (%)

Composite groups (% rate)	2 hour	24 hour	48 hour	1 week	4 week
PP (%0)	0	0	0	0	0
FK 1(%30)	0,92	1,50	1,57	2,11	3,10
FK 2(%40)	0,89	4,31	2,55	3,87	5,66
FK 3(%50)	1,51	4,74	5,92	9,03	11,12

Table 3 Water Intake Rates (%)

Composite groups (% rate)	2 hour	24 hour	48 hour	1 week	4 week
PP (%0)	0	0	0	0	0
FK 1 (%30)	0,43	1,37	1,66	3,77	6,74
FK 2 (%40)	0,62	1,93	2,37	6,12	10,60
FK 3 (%50)	0,56	1,90	2,57	5,86	12,83

It has been observed that with the increase in the proportion of lignocellulosic material in the produced composites, the percentage increase in thickness and increase in water intake rates. Stokke & Gardner (2003) stated in their study that the rate of water uptake is significantly affected by the increase in the ratio of the hydrophilic woody material in the composite material.

D. CONCLUSION

In this study, polymer composite was produced using hazelnut shell flour and polypropylene, which are agricultural waste. Physical and mechanical test values of the produced composites were determined. All composites using hazelnut shell flour. It was observed that the resistance values of the plate produced using pure polypropylene were higher than the shock resistance value. It was determined that with the increase in the ratio of hazelnut shell flour used in different amounts, a decrease was observed in all mechanical values, while the rate of swelling in thickness and water intake increased. It was determined that the best result was obtained in composites using 30% hazelnut shell flour. However, when the bending strength and elastic modulus values of the produced composites are examined, it has been seen that they provide the values specified in ASTM D6662 (2001).

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