DEGRADATION OF PLA-NATURAL FIBER COMPOSITES UNDER CONTROLLED COMPOSTING CONDITIONS AND ITS EFFECT ON TENSILE PROPERTIES

Erick Omar Cisneros-López[1], Aida Alejandra Pérez-Fonseca[1], Yolanda González-García[2], Carlos Federico Jasso-Gastinel[1], Daniel Edén Ramírez-Arreola[3], Jorge Ramón Robledo-Ortíz[2]

1. *Departamento de Ingeniería Química, Universidad de Guadalajara, Blvd. Gral. Marcelino García Barragán No. 1451, 44430, Guadalajara, Jalisco, México.*
2. *Departamento de Madera, Celulosa y Papel, Universidad de Guadalajara, Carretera Guadalajara-Nogales km 15.5, Las Agujas, 45510, Zapopan, Jalisco, México. jorge.robledo@cucei.udg.mx*
3. *Departamento de Ingenierías, Universidad de Guadalajara, Av. Independencia Nacional No. 151, 48900, Autlán de Navarro, Jalisco, México*

Introduction

The use of cellulosic fibers to reinforce polymers has received much attention in recent years because of their ecological character, low cost and high specific properties.[1] Nevertheless, petroleum-based polymers have the disadvantage of not being biodegradable, for this reason, the demand for biodegradable polymers such as polylactic acid (PLA) has recently increased.[2] PLA has become one of the most used biopolyesters for the food packaging industry due to its easy processability, superior properties and reasonable rate of disintegration in compost.[1] In this work, PLA biocomposites were produced by a combination of extrusion and injection molding with three different cellulosic fiber reinforcements (agave, coir, and pine). The composites degradation under a compost and its effect on tensile properties and weight loss were studied.

Experimental Part

The matrix used was PLA 3251D (NatureWorks LLC). Agroindustrial residues of natural fibers were obtained in Mexico to be used as reinforcement: agave fibers (*Agave tequilana* Weber var. Azul), coir fiber (*Cocos nucifera*) and pine sawdust (*Pinus* spp.). The fibers were milled and sieved to keep particles between 50 and 70 mesh. Composites were produced with 20 wt % of fibers in a twin-screw extruder Leistritz Micro 27 GL/GG 32D. After extrusion the composites were pelletized and oven-dried in order to be processed by injection molding on a NISSEI PS 60E9ASE with a temperature profile of 165/185/190/185 °C. The samples molded were type IV dog-bone specimens (ASTM D638). The degradation under composting conditions of PLA and composites was carried out according to ISO 20200 standard during 3 weeks. Tensile properties were measured on an INSTRON model 3345 universal testing machine.

Results and Discussions

Figure 1 shows the tensile properties and weight loss of composites and PLA. The fibers presence delays the degradation; however, since the fibers promote the direct and rapid ingress of water and microorganisms into the composite[2], positive degradation results for weight loss (specially coir) and strength (in all composites) can be observed since the second week composting; pine samples lost physical integrity after three weeks. Figure 2 presents typical images of the materials before and after composting showing the darkening effect caused by oxidation with composting time.

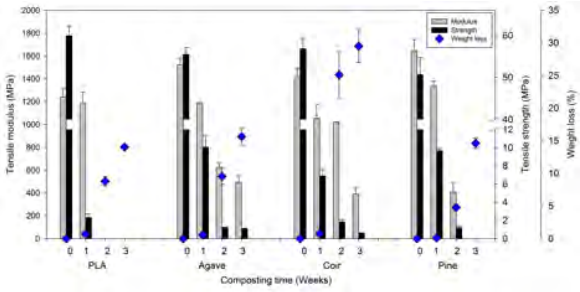

Figure 1. Tensile properties and weight loss of PLA and composites under controlled composting conditions.

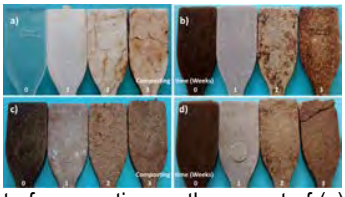

Figure 2. Effect of composting on the aspect of (a) neat PLA and the composites: (b) PLA–agave, (c) PLA–coir, and (d) PLA–pine.

Conclusions

The fibers promote an increase in modulus, with a decrease in material cost. Coir fibers promoted the highest weight loss showing the preference of microorganisms. The degradation was reached with all cellulosic fibers.

Acknowledgment: CONACyT; *cucei.udg.mx*

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