Association Between Plasticized Starch and Polyesters: Processing and Performances of Injected Biodegradable Systems

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Different formulations of wheat thermoplastic starch (TPS) have been processed with various plasticizer/starch ratios and moisture contents. The biodegradable polyesters tested are polycaprolactone (PCL), polyester amide (PEA), polybutylene succinate adipate (PBSA) and polybutylene adipate co terephtalate (PBAT). TPS and polyesters are melt blended in different proportions by extrusion and then injected to obtain dumbbell specimens. Various properties are evaluated such as the mechanical properties (tensile and impact tests), and the hydrophilic character with contact angle measurements. Additionally, uniaxial shrinkage is evaluated. Results show that the addition of polyester to TPS increases the dimensional post-injection stability. Blend modulus values are close to the results of the classical rule of mixture. Elongation at break, resilience values and SEM observations seem to give some indications about the compatibility between both polymeric systems. PBAT and PEA present better results than PCL and PBSA. Contact angle measurement show that we have a drastic increase of the hydrophobic character from 10% of polyester in the blend. The different combinations of TPS and polyesters give a wide range of mechanical behavior for compostable materials, to be developed in specific applications.

INTRODUCTION

The use of agricultural products in plastics applications is considered an interesting way to reduce surplus farm products and to develop non-food applications. Starch-based materials have received considerable attention as an alternative to synthetic polymers obtained from petroleum. During the last decade, several developments were made to convert native starch into a plastic-like material (1). The so-called "thermoplastic starch" (TPS) is obtained from native starch by disruption and plasticization. Both mechanical and thermal energies are needed to obtain a TPS molten phase. TPS presents various attributes. Beside its biodegradability, it is a naturally occurring renewable polymer and the raw material is inexpensive. For applications, its development is limited owing to the mechanical properties and the moisture sensitivity of the material (2, 3). To overcome these weaknesses, association of plasticized starch with another biodegradable polymer is a way to obtain low-cost and compostable materials (2, 3). To associate plasticized starch with another polymeric system, blending is easier than the co-extrusion process (4). TPS has been widely used in blends with other polymers. Some starch-based blends have been commercialized, e.g. Mater-Bi (Novamont-Italy) (5, 6). In the past, blends with synthetic polymers, such as polyethylene, have been developed (7), leading to incompletely biodegradable materials. To maintain the compostability feature of the blend, biodegradable thermoplastic components like polyesters are used: polycaprolactone (PCL) (2, 6, 8–13), polyesteramide (PEA) (3), polyhydroxybutyrate-co-valerate (PHBV) (11, 12, 14, 15), polybutylene succinate-adipate (PBSA) (16). Thermoplastic biodegradable polyesters present a large range of commercial polymers, with different chemical structures (2–4, 6, 9–14, 16–19) (*Table 1*).

The present work analyses the behavior of various biodegradable polyesters blended with plasticized

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