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Degradation of PLA during long-term storage

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The degradation of PLA proceeds through hydrolysis of the ester linkages in the polymer backbone. This leads to a significant reduction of molecular weight and thus to a deterioration of mechanical properties. However, up to now there are no studies of PLA-hydrolysis performed under practical conditions and long-term storage. In this work, the influence of molecular weight, granule size, crystallinity, air humidity and temperature on the hydrolytic degradation of PLA was investigated. Two commercially available PLA types with different molecular weights were used in this study. Three different granule sizes were prepared through compounding with a co-rotating twin-screw extruder. The granules were annealed at defined temperatures so that crystallinity degrees in three different magnitudes were generated. Finally, all granules were stored at five different temperatures in the range from 10 to 50°C and a relative humidity of 33 and 75 % for six months. During this time, the viscosity of the samples was monitored with a rotational rheometer. A simple linear function was used to define the relationship between the weight average molecular weight and the zero viscosity in logarithmic form. By fitting the zero viscosity in the simplified kinetic equation, the degradation rate constants for each sample at each temperature were determined and used afterward in the Arrhenius equation to calculate the activation energy of the hydrolytic degradation for each sample. As most significant influences on the hydrolytic degradation of PLA, temperature and air humidity were identified. The degradation rate constants and therefore the rate of the hydrolytic degradation, increase significantly with increasing temperature and air humidity. Furthermore, small granules, high crystallinity and high molecular weight increase the activation energy and thus reduce the rate of PLA degradation during the long-term storage.

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Starch-Yerba mate films - Biodegradability, antioxidant and plasticizing effect of yerba mate extract on cassava starch edible films

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Packaging has a key role in containing and protecting food since it is highly manipulated by producers and consumers. However, packaging materials are one of the main solid wastes in major cities of the world. Cassava starch constitutes a useful alternative to develop eco-friendly materials to replace that from petroleum due to its advantages such as biodegradability, low cost and availability. The incorporation of additives from natural sources into starch films is a new strategy to improve the shelf-life of food products and the functionality of a packaging. In this sense, antioxidants (yerba mate extract), proteins (from lentil) and micro/nano fillers (from lentil and starch) were investigated because the important properties that they can transmit to a food product such as antioxidant, anti-inflammatory and anti-mutagen, or protean effects, and as reinforcement of food packaging. Starch-glycerol films with antioxidants and protein presented improvements in the strain at break, showing materials with more flexibility, as a typical behavior of a plasticized film. The plasticizing effect of these additives was also confirmed from water vapour permeability, thermogravimetric and mechanic dynamic properties. The use of lentil microparticles and starch nanoparticles showed significant reinforcing effect. The effects observed on cassava starch based films, derived from the incorporation of antioxidants, protein and particles, makes us to think about the different potential uses of these films as coating and/or packaging of food products in order to retard their oxidation, avoid chipping or cracking during handling, increase their shelf life, and/or as reinforcement of their cover.

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