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ORIGINAL RESEARCH

Lauric acid-grafted barley (*Hordeum vulagare* L.) husk for application in biocomposite films: optimization method in synthesis and characterization

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Abstract

Lauric acid-grafted barley (*Hordeum vulgare* L.) husk (BH) samples were prepared in the presence of redox initiators. The effect of reaction time, reaction temperature, dimethyl sulphoxide content, and concentration of lauric acid on the percentage of graft yield of BH was studied through one-variable-at-a-time approach. A second-order mathematical response model was developed using response surface methodology coupled with central composite design to examine the individual and combined effect of grafting reaction parameters on the percentage of graft yield of BH. The regression model showed a good fit with the experimental data with high correlation coefficient ($R^2 > 0.97$). Grafted BH samples were characterized using Fourier transform infrared spectroscopy, X-ray diffractometry, scanning electron microscopy, and thermal analysis techniques. Crystallinity of BH decreased from 55.5 to 30.22% after grafting with lauric acid due to destruction of crystalline structure of BH during grafting reaction. Grafted BH was more thermally stable as compared to BH. Water contact angle of grafted BH was higher than that of BH, indicating the improved hydrophobicity of BH after grafting. Swelling studies of grafted BH samples in different solvents such as water, ethanol, and dimethyl formaldehyde were performed and compared with BH.

Keywords Biopolymers · Grafting · IR spectra · Swelling · Thermal properties

Introduction

Nowadays, research efforts have been made to replace petroleum-based polymers and plastics with biodegradable or ecofriendly materials due to environmental requirements. Among various materials, cellulose is the most abundant biodegradable polymer found in nature, which is mainly present in the lignocellulosic fibers. Properties associated with cellulosic fibers, such as availability of raw material, low density, recyclability, and biodegradability make them suitable as reinforcing agents in polymer composites [1–3].

However, the application of these fibers as reinforcing agent in composites has been restricted due to the large number of hydroxyl groups present on their cellulosic backbone. Therefore, various chemical and physical modification techniques such as plasma treatment [4], alkali treatment [5], acetylation [6], esterification [7], silane treatment [8], benzoylation [9], and graft copolymerization [10, 11] have been tried in functional transformation of hydroxyl groups on the fibers. Totolin et al. [12] have grafted the Spanish broom (*Spartium junceum*) fiber with short and long fatty acids (butyric acid, oleic acid, and a mixture of fatty acids from olive oil). They observed that the grafting of saturated and unsaturated fatty acids onto the fiber led to improvement in thermal stability of fibers. Popescu et al. [13] also reported that the softness and hydrophobicity of the fibers were enhanced after grafting of softwood craft pulp fibers with fatty acids under cold plasma conditions. Salem et al. [14] showed that, after treatment of kenaf fiber with stearic acid, the water absorption of kenaf fiber dropped with increase in stearic acid concentration.

Various researchers have performed the grafting of natural polymers with lauric acid to enhance their thermal

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