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ORIGINAL PAPER

Converting date seed biomass into highly absorbing hydrogel

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Abstract Converting biomass into value-added products has attracted great attention in recent years. In this paper, a facile approach for using date seed powder without delignification is introduced to convert date seed biomass into a water-absorbing polymer. The biomass of date seed as a source of polysaccharides was immersed in the emulsions of acrylic microgels with different chemical structures. Different polymer latexes based on acrylic acid (AA), sodium acrylate (SA), acrylamide (AM) and 2-acrylamide-2-methyl propane sulfonic acid (AMPS) were prepared using inverse emulsion polymerization. A chemical reaction was carried out between date seed and acrylic latex by heating, which caused the conversion of date seed into a semi-synthetic hydrogel with 60 % natural and 40 % synthetic components. The best modification of date seed to absorbing hydrogel was obtained with poly(AA–SA–AM–AMPS). The modified date seed with this latex had water absorbency of up to 71 g/g, while the unmodified date seed had only 0.2 g/g water absorbency. Date seed hydrogels were characterized by Fourier transform infrared spectroscopy (FTIR), dynamic mechanical thermal analysis (DMTA), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), rheometric analysis and swelling measurement. The effect of several modifications of parameters such as latex type, AMPS content in latex, aquatic–organic phase ratios of latex and modification temperature on the swelling properties of hydrogel was investigated. The obtained hybrid hydrogel based on date seed biomass contained a considerable amount of biomass in its structure as well as 71 g/g water absorbency, which can be a proper candidate for agricultural applications.

Keywords Hydrogel · Inverse emulsion polymerization · Biomass · Absorbing polymer · Date seed

Introduction

In the field of polymer products, in the late twentieth century, researchers found that synthetic polymers influence on the global market is decreasing [1]. In contrast, the world population has been increasing. Reduction in the growth of oil-based synthetic polymers indicates that the world is attempting to understand and adapt to green concepts (green chemistry, green technology, etc.). Given that today's human life is completely dependent on polymers, it seems that natural modified and synthetic hybrid polymeric materials are gradually replacing the synthetic types [2–4].

Among natural and renewable resources for obtaining biopolymers, biomass which is referred to as a group of living and non-living materials (except for oil, gas and coal) or a group of organic and renewable materials plays a critical role. It is estimated that 400.000 million tons of biomass are annually produced on the Earth and natural polymers account for a considerable part of these materials [5]. One of the most important types is vegetal biomass, which is mainly a lignocellulose material. Lignocelluloses, as the main vegetal biomass, are complex combinations of three biopolymers containing polysaccharides, cellulose and hemicellulose, and polyphenolic compounds, lignin [2, 4, 6]. These materials have long received attention due to some benefits such as abundance, non-toxicity, low price, sustainability and bio-degradability [2]. These bio-based

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