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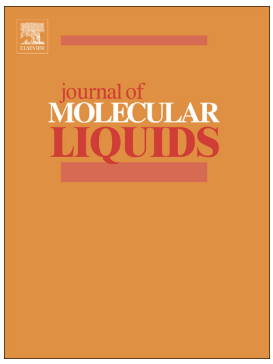

Synergistic effect of the sequential intercalation of three types of surfactants in the exfoliation degree of bentonite clay in films of cassava

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ACCEPTED MANUSCRIPT

SYNERGISTIC EFFECT OF THE SEQUENTIAL INTERCALATION OF THREE TYPES OF SURFACTANTS IN THE EXFOLIATION DEGREE OF BENTONITE CLAY IN FILMS OF CASSAVA

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Abstract

A method of obtaining exfoliated nanocomposite films based on biopolymers has been reported. The method is based on the incorporation of modified bentonite clay by mixing surfactants into a biodegradable matrix. The biopolymer used was cassava starch, which has a high hydrophilicity, which makes it less desirable than synthetic polymers, when used as a film matrix for coating. The improvement of this was proposed with the formation of a nanocomposite matrix by the high exfoliation of the modified bentonite clay used as reinforcement material. The degree of exfoliation of the sequential modification in bentonite with three surfactants throughout the cassava starch film was investigated by XRD, FTIR, AFM, SEM, OM and contact angle. The physicochemical properties of the nanocomposite films were analyzed for water vapor permeability, ductility, opacity, thermal stability and water solubility. Finally, the clay modified in the presence of the three surfactants was the reinforcement material that contributed the most to the physicalchemical properties of the control starch film, among which it reduced 90.6% of the water vapor permeability, as well as 77.43% of the maximum dissolution.

Keywords: biodegradable film; nanocomposite; physicochemical properties; modified clay; surfactants

1. Introduction

The use of biopolymer films in the food industry as packaging for coating offruit and vegetable is increasing due to the intense demand for good products [1,2]. This occurs from biopolymers being biodegradable matrices from renewable sources that can reduce environmental pollution caused by non-degradable synthetic polymer residues [3]. To compete with these conventional materials, biopolymers must have their physicochemical properties modified, since their hydrophilic nature influences the barrier properties of the coating [4]. Therefore, the demand for an edible coating that is sustainable and with excellent water vapor barrier, mechanical, optical and thermal properties is a challenge.

Cassava starch, cheap and affordable product, is considered to be one of the most promising candidate materials for the manufacture of biodegradable films [5]. However, low thermal, optical, mechanical and water vapor barrier properties limit the starch-based films to be used [6]. An option to improve these properties is the incorporation of clay minerals as reinforcing material to the biopolymer matrix forming bionanocomposites [7,8].

In this perspective, bionanocomposite films have improved physicochemical properties in relation to the original biofilm, considering that nanomaterials are scattered to the biopolymer matrix giving it a barrier character [6]. However, the simple mixing of biopolymer and clay minerals does not always result in the generation of a bionanocomposite, since the degree of dispersion of the clay minerals in the biopolymer matrix is directly related to obtaining a film with uniform properties. This difficulty is due to the weak interactions between the biopolymer and the natural clay, resulting in an intercalated dispersion of the reinforcing material in the biopolymer matrix [9,10].

The solution of this, in turn, is for the natural clay to present counter-ions on the intercalated surface of the silicate layers, which favors the ion exchange reaction with modifiers through hydrogen bonds [11]. Such modifiers provide space and compatibility for the biopolymer structure to interlace and thus

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