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Title: Dispersion of halloysite loaded with natural antimicrobials into pectins: Characterization and controlled release analysis

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1 **Dispersion of halloysite loaded with natural antimicrobials into pectins: characterization and**
2 **controlled release analysis**

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11 **Abstract**

12
13 This paper reports the preparation and characterization of green composites based on pectins and
14 nano-hybrids composed of halloysite nanotubes (HNTs) loaded with rosemary essential oil.
15 Different hybrid percentages were mixed into a pectin matrix, by ball milling in the presence of
16 water. Cast films were obtained and analyzed. Structural organization and physical properties
17 (thermal, mechanical, barrier to water vapor) were correlated to the nano-hybrid content. A
18 preliminary study on the kinetics of release of the rosmarinic acid, chosen as a model molecule, was
19 also performed. This work showed the potential of these systems in the active packaging field
20 where controlled release of active species is required.

21
22 *Keywords: pectins, halloysite, green composites, active packaging, controlled release*
23

24 **1. Introduction**

25
26 In the last few years, the possibility of using products from the agriculture and food industry to
27 develop new biodegradable materials for packaging applications is rapidly growing. Furthermore, in
28 food packaging, extending the shelf life of packed products is a critical issue. The development of
29 innovative packaging materials where different functionalities are included in a single film layer
30 is of considerable interest. Nanotechnology is a very promising strategy for improving physical
31 and barrier properties of polymeric materials. The introduction of nanofillers into biopolymers has
32 been shown to be a good strategy to overcome some critical issues, such as a poor barrier to water
33 vapour and low mechanical properties [Sorrentino, Gorrasi, & Vittoria, 2007; Lagaron, & Lopez-
34 Rubio, 2011]. Natural pectins are green emerging materials for food packaging applications. They
35 can be found in the primary walls of the cells and show a complex hetero-polysaccharide structure,
36 containing linear and branched regions [Siew, & Williams, 2008]. The degree of esterification,

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