Diffusion mechanisms of solutes in edible packaging materials – comparison between macro and nano scale

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The concept of active and intelligent packaging and the use of biopolymers for food packaging have received a lot of interest over the last years. Transport mechanisms of bioactive compounds in biopolymer matrices are an important factor in the development of such packaging solutions. Biopolymers obtained by natural resources (e.g. chitosan) have been proved to be nontoxic, biodegradable, and biocompatible and in many cases have bioactive properties. Such properties led to a great number of applications in food, pharmaceutical and bio-medical industries over the last years. The main objectives of this work were to investigate the diffusion mechanisms of bioactive compounds from chitosan-based films under different environmental conditions, and to evaluate the transport mechanisms at the nano-scale. Diffusion of bioactive compounds from chitosan films and from nanolayered biopolymer films was investigated by obtaining experimental data on the release kinetics of bioactive compounds under different conditions. The most appropriate mathematical models were selected from literature and were fitted to the experimental data using non-linear regression. Results showed that at the macro-scale, transport of bioactive compounds from polymeric films followed a Linear Superimposition Model which accounts for both Fickian transport behaviour and polymer relaxation (case II transport), due to solutes' release from the matrix disentangled by swelling. For the release of compounds from nanolayered films, the transport mechanism followed a Fickian behaviour – indicating that transport was only driven by the concentration gradient with no evidence of polymer reconfiguration due to contact with a liquid medium.