Effective permeation barriers for taste relevant aroma compounds: Characterization of the biopolymer Chitosan coated on paper substrates

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Introduction

Effective protection of food products is of essential importance for maintaining food quality during storage. Barrier properties of packaging materials therefore comprise the classical aspects of moisture, light and gas barriers as well as of aroma / odour barriers, which are receiving growing attention. Due to the interaction between food, package and environment, processes like permeation, migration and absorption may take place. Considerable amounts of aroma / odour compounds can be absorbed by packaging materials ("flavour scalping") or can permeate through the packaging, both resulting in the loss of aroma intensity or an unbalanced flavour profile. In addition to the preservation of the aroma of the packaged product, flavour / odour barriers prevent undesired external flavours and odours from reaching and contaminating the product. In general, paper shows only very low barrier properties, also in respect to the transmission of organic compounds. It is a common approach to improve the barrier properties of papers by coating a thin layer of a material, that provides good intrinsic barrier properties.
Within the EU Project "Sustainpack" different kinds of paper were coated with the biopolymer chitosan. Chitosan is derived by chemical conversion from natural chitin. Chitin is a derivative of cellulose consisting of β-1,4-linked 2-acetamido-2-desoxyglucose units and is naturally occurring in the shells of crustaceans like crab, shrimp and crawfish. The conversion of chitin to chitosan is achieved by deactetylation of the acetamido groups. The aim of this task was to measure comparatively the permeation of volatile organic compounds through chitosan coated paper samples and a pure chitosan film, as well as to determine the solubility of these compounds in the respective materials. This was achieved by a well established permeation method using several organic compounds as test permeants, that are occurring as odour / aroma in foods or are being used as odour / aroma in non-food products, respectively [1,2]. They represent different polarities and molecular weights and therefore allow to predict the barrier behaviour against other flavour compounds.

Results

We examined the permeation of seven volatile food components through a pure chitosan film and a series of chitosan coated paper samples. The permeation process of the flavour / odour compounds was characterized by permeation curves (Figure 1 and 2) as well as by calculated permeation rates, estimated break-through times and relative solubilities of the test compounds in the sample materials.
The investigated pure chitosan film exhibited in principle good aroma barrier properties, as indicated by low permeation and solubility rates. Also, a break-through of the respective test permeants was not detectable before approx. 1000 hours (42 days) of storage. Therefore the aroma barrier properties of the pure chitosan film are comparable to those established for conventional plastic materials like PET. Due to the pore structure and the materials' polarity, pure paper samples show very low aroma barrier properties for the organic test compounds. For the chitosan-coated paper samples a slight improvement of the aroma barrier properties compared to the uncoated papers was observed. This is indicated by reduced permeation rates as well as by the shift of breakthrough times to up to seven days. However, the monitored breakthrough times were significantly shorter for chitosan coated papers than for the pure chitosan film (approx. two to seven days compared to more than 42 days).

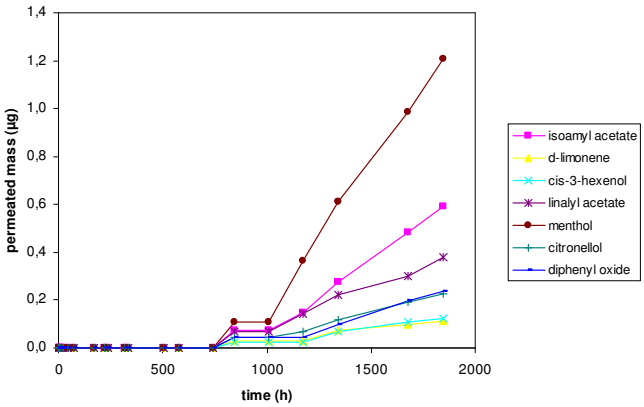

Figure 1: Permation curve obtained for the pure chitosan film

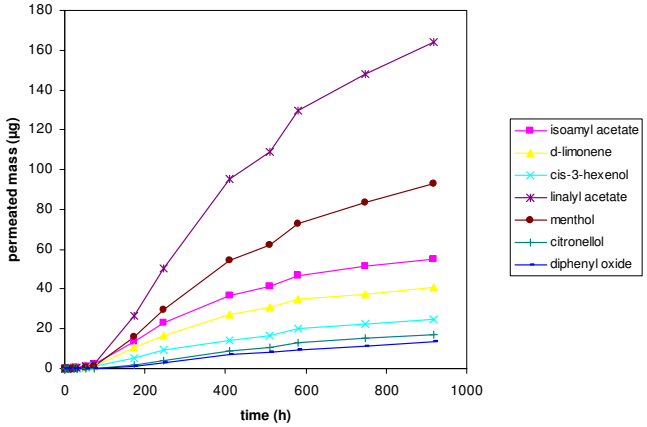

Figure 2: Permeation curve obtained for a representative chitosan-coated paper sample

The good aroma barrier properties of the pure chitosan film compared to the coated papers are based predominantly on the greater thickness of the chitosan film compared to the relatively thin chitosan coatings on the papers. The reduced thickness of the chitosan coating combined with the possible penetration of the chitosan into the paper may also implicate that pin holes in the paper structure were not completely covered and sealed by the chitosan coating. Therefore the permeation process through the paper was not inhibited by the coating sufficiently allowing a more rapid permeation of the test compounds through the chitosan coated paper.

Conclusions

Based on the measurements, the permeation process and therefore the barrier characteristics of chitosan on paper substrates were characterized by permeation rates, estimated breakthrough times and the relative solubility of the respective aroma compounds in the barrier material. In summary, our measurements indicate that the aroma / odour permeation through paper can in principle be decreased or inhibited, respectively, by coating with the biopolymer chitosan. However, in order to achieve sufficient aroma / odour barrier properties, an optimization of the chitosan coating thickness as well as the used paper material must be addressed.

References

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