Application of adsorbent materials for the simulation of the migration of MOSH and MOAH from food packaging into food items

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Introduction

MOSH, mineral oil saturated hydrocarbons, and MOAH, mineral oil aromatic hydrocarbons, are known as impurities in paper based food packaging made of recyclates and/or colored with mineral oil based printing inks [1]. As MOAH are assumed to be carcinogenic the migration of those substances into food items should be avoided [2]. A lot of works dealing with mineral oil contents in packaging and food products were published [3,4]. Less research was done relating to the usage of adsorbent materials to simulate conveniently and more realistically the migration of MOSH and MOAH into food [5]. This study deals with the investigation of adsorptive simulants to simplify the analysis of MOSH and MOAH migrating from packaging into food items.

Method

As food simulating media Tenax® and SorbStar® were used. Migration tests were done in glass migration cells. Four cardboards of different mineral oil content were placed in direct (Tenax®, SorbStar®) and indirect contact (Tenax®) to the adsorbents. Temperatures of 20°C, 40°C and 60°C were chosen. Storage times varied between 1 and 12 days. The food simulants were then statically extracted with a mixture of ethanol and n-hexane. The n-hexane phase can be separated by solvent extraction with ultrapure water. The extracts were quantitatively analyzed for MOSH and MOAH content using online-coupled HPLC-GC-FID (HPLC: 1260 Infinity, Agilent Technologies; GC: Master GC, DANI; application by Axel Semrau). Quantification was based on internal standards. The results were compared with the initial concentrations found in the cardboards to calculate the migration ratio.

Results

Despite different mineral oil contents of the cardboards the experiments resulted in similar migration behavior. The migration rates of MOSH for all four cardboard samples in direct contact with Tenax® at 60°C are exemplarily shown in Figure 1. With the exception of the MOSH fraction C_{10}-C_{16} of cardboard C all trend lines are equal. As a reason for the inconsistency an influence by the cardboard grammage is assumed.

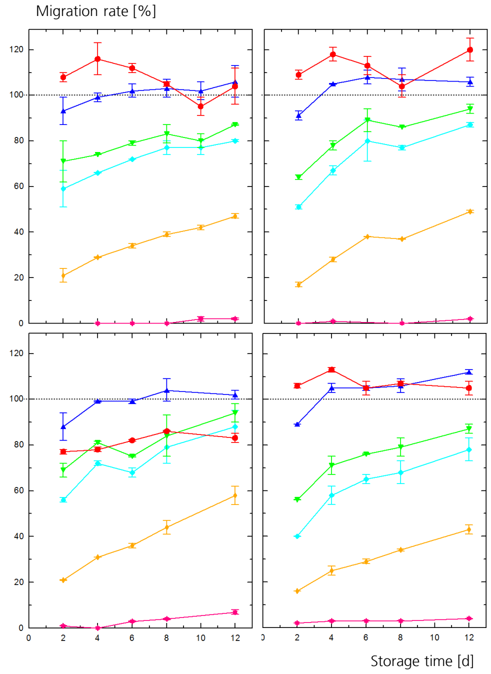

Figure 1: Migration rates in % of MOSH migrated into Tenax® in direct contact to cardboard at 60°C for several storage times; top left: cardboard A, top right: cardboard B, bottom left: cardboard C, bottom right: cardboard D; MOSH fractions: red: C_{10}-C_{16}, blue: C_{16}-C_{20}, green: C_{20}-C_{24}, light blue: C_{24}-C_{25}, orange: C_{25}-C_{35}, pink: > C_{35}

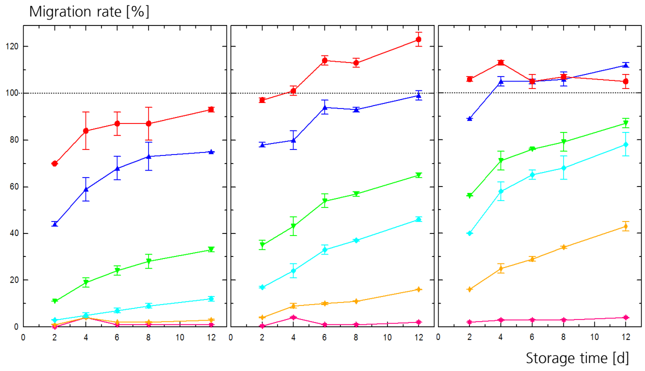

Figure 2: Migration rates in % of MOSH migrated into Tenax® in direct contact to cardboard D at 20°C (left), 40°C (middle) and 60°C (right) for several storage times; MOSH fractions: red: C_{10}-C_{16}, blue: C_{16}-C_{20}, green: C_{20}-C_{24}, light blue: C_{24}-C_{25}, orange: C_{25}-C_{35}, pink: > C_{35}

MOSH and MOAH migrate similarly, despite differences and numerous possibilities in the molecular structure. Furthermore, Tenax® was found to have a higher adsorptive capacity in direct contact than for gas phase transfer. With the increase of temperature, time and the decrease of molecular size the migration rates rose. As an example Figure 2 shows the migration rates of MOSH for cardboard D in direct contact with Tenax® at 20°C, 40°C and 60°C.

For SorbStar® adsorbent it was found that it is more limited to the adsorption of high volatile substances independent of the type of contact. Therefore, SorbStar® in direct contact to cardboard shows results similar to those of Tenax® with indirect contact to cardboard.

Conclusions

With these experiments it is assured that both Tenax® and SorbStar® have the potential of simulating appropriately real mineral oil migration into foodstuff. Additionally, SorbStar® is a cost-effective, disposable item, which can be an alternative to Tenax® in those applications.

As the migration of MOSH and MOAH from cardboard into simulant media proceeds similarly, despite the differences in mineral oil contents, the transferability from real to simulated migration is simplified. With both simulant media a large range of food items can be simulated: e.g. powdery and free-flowing goods as well as fatty products by Tenax®, products rather affected by mineral oils through gas phase transfer and chunky goods by SorbStar®.

Due to numerous experiments with the investigation of the parameters temperature, storage time, type of mineral oil contamination and molecular size, optimal conditions for simulations can be examined. Following comparative studies with packed food products will improve the knowledge about the parameters to be chosen for the simulation of migration.

References

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