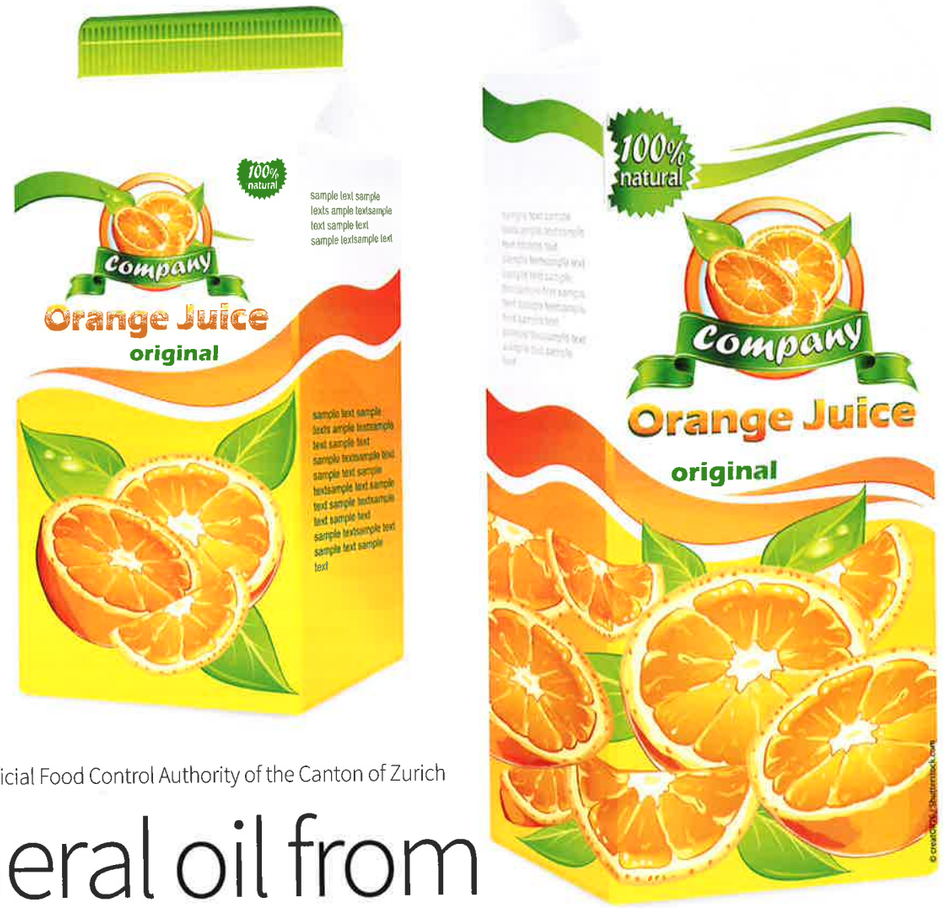


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# Mineral oil from recycled paperboard: recent progress

**In 1989, the European Scientific Committee on Food (SCF), the predecessor of the EFSA, evaluated mineral oil and established a temporary tolerable daily intake (TDI) of 0.005-0.05 mg/kg body weight (bw) depending on oil quality. Using the usual assumptions this relates to migration limits of 0.3-3 mg/kg food. As the mineral oil migrating from recycled board contains 15 – 20 per cent mineral oil aromatic hydrocarbons (MOAH), the lower limit applied, which was usually exceeded roughly 100 times.**

Little attention was paid to the limits until late 2009, when the German Federal Institute for Risk Assessment (BfR) stated that the migration of mineral oil from recycled paperboard in food contact should be urgently minimised. The problem was twofold: mineral oil migrated from the printing inks applied to the box as well as from the recycled board contaminated by the printing inks used in the recycled material, such as the newspaper. This led to the classic dilemma: even though it had been well known for two decades that migration into food was far too high, industry was not prepared. For authorities, it was difficult to accept that problems were only tackled after it created enough pressure – mainly via the media, as other reminders remained unanswered.

## Toxicological evaluation

In June 2012, the EFSA published an opinion on mineral oils focusing on human exposure and toxicology. As there are probably carcinogenic components among the aromatic hydrocarbons (MOAH), no safe dose could be established. For saturated hydrocarbons (MOSH), the database was considered insufficient because of insufficient specifications of the mixtures used for testing and unknown accumulation in human tissues. There was potential concern associated with the current exposure to MOAH as well as MOSH. It was also stated that migration from recycled paper packaging contributes significantly to the total exposure.

MOSH have recently been shown to be by far the largest contaminant in the human body, sometimes exceeding 10 grams per person. Some hydrocarbons might be accumulated over a lifetime due to a lack of routes for elimination. Microgranulomas, droplets of MOSH surrounded by immune cells, were found in human tissues 50 years ago. The composition of MOSH in human tissue also questioned the previous evaluations that considered white oils (MOSH) of moderately high molecular mass of low concern: a large part of these oils falls into the range of strongly accumulated hydrocarbons.

In 2011, the German Federal Institute for Risk Assessment (BfR) set a migration limit for the $C_{10}$-$C_{16}$ MOSH (white oils used as solvents) of 12 mg/kg food on the basis that they are not accumulated in the human body. In 2012, it specified a limit of 4 mg/kg for the subsequent fraction of the $C_{17}$-$C_{20}$ MOSH, again on the basis that these are hardly observed in rat liver (but they are in other organs). The next higher molecular mass MOSH, those between $C_{20}$ and $C_{30}$, correspond to the most severely accumulated ones and using the same criterion, a substantially lower limit is to be expected.

## Regulation

The European Commission has no intention of regulating paper and board. The first draft (2010) for the German regulation on mineral oil migrating from paperboard provided legal limits in foods of 0.6 mg/kg for MOSH and 0.15 mg/kg for MOAH. The limit for the MOSH was derived from the acceptable daily intake (ADI) of 0.01 mg/kg bw of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) for corresponding oils. However, after publication of the EFSA opinion, JECFA withdrew this ADI. Primarily for analytical reasons, the second draft (2013) only included the 0.15 mg/kg limit for the MOAH, but also this proposal was heavily criticised and a third proposal is awaited.

At the end of 2012, the Austrian Ministry of Health published the recommendation that foods packed into recycled paperboard should be protected by a functional barrier (BMG-75210/0018-II/B/13/2012). Switzerland did not react by drafting specific legislation, since the migration clearly violates the general rules of Article 3 of the European Framework Regulation 1935/2004 and the Swiss analogue that the migration must not endanger human health.

The main technical problem is related to difficulties in determining migrated mineral oil. The analysis is demanding as such, mostly carried out by on-line coupled HPLC-GC, a technique only available in a few laboratories. Hardly any producer is able to perform this analysis, and in the past too many service laboratories delivered unsatisfactory results. Many foods already contain mineral oil before packaging, which mostly can be distinguished from that migrated from paperboard by its composition, but presupposes some experience. Finally, the legal limit must be respected up to the end of the shelf life, which may require years of testing, since there is no reliable method for accelerated simulation. Instead of measuring migration, compliance could be shown by arguments, such as that an adequate barrier has been used or referring to a study showing that during short storage, the limit will not be exceeded.

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## Discussions about the way out

To reliably respect a limit of 0.6 mg/kg food, the MOSH content in the recycled paperboard should be below about 5 mg/kg. However, even with special care (sorting out newspaper), it is difficult to produce

recycled paperboard containing less than 100 mg/kg MOSH. The producers of recycled paperboard urged the printing industry, particularly newspaper printers, to replace the mineral-oil-based inks. This was shown to be technically feasible, but printers resisted because of costs and little prospects that with the global exchange of material, the necessary reduction of the MOSH content could be achieved.

Mineral oil is, however, not the only substance of concern in recycled paperboard. In 2010, the German authorities launched a project to produce an overview of the substances potentially migrating from recycled paperboard. For a typical recycled paperboard, roughly 250 substances were detected that were likely to migrate into dry food stored at ambient temperature for at least a few months above a threshold of concern defined as 0.01 mg/kg food (the conventional European detection limit). For most of these substances, safety has not been evaluated; approximately a third could not even be identified. It was concluded that the safety could not realistically be ensured for that many substances, also taking into account that their composition depends on the recycled material and new substances could always appear, since the recycled paper and board used was not made to be later used in food contact.

## Functional barriers

There is broad agreement that the large amount of recycled paperboard used for food packaging cannot be replaced by fresh fibreboard. It has also been shown that foods packed in fresh fibreboard but stored and transported in larger boxes, usually of corrugated board, is also contaminated at levels exceeding the envisioned migration limits.

The most promising solution is in functional barriers protecting the food; either built into internal bags or, if there is no such bag, placed onto the internal surface of the board. Aluminium foils of sufficient thickness are considered absolute barriers, but are not first choice because of ecological considerations. Also, many polymers are effective barriers against migrants from paperboard: PET, polyamides, EVOH, PVDC, PLA, cellophane and probably others. Efficiencies vary enormously: while breakthrough occurs in terms of hours for PE, it may take more than 100 years for, e.g., PET of the same film thickness.

As these properties are hardly related to the well-known and easily measurable permeation of gases or humidity, a new method was developed: a donor paper with surrogate substances is tightly fixed to one side of the barrier, while a receptor, a silicone paper, enables detection and measure breakthrough. It detects both migration through the polymer as well as through deficiencies in the layer, such as pinholes or scratches. Measurement of efficiency is a prerequisite for establishing barriers recognised as adequate for given applications. In Switzerland, work is ongoing to establish an industry standard for barriers against the migration from recycled paperboard. The use of barriers respecting such standards might become the main route for showing compliance.

Multilayer films with an efficient barrier to make internal bags are available. In a survey performed during June 2013 in Germany and Switzerland, 87 dry foods packed in recycled paperboard with internal bags were investigated. Just 17 bags (20 per cent) consisted of paper or polyethylene i.e. had no relevant barrier properties – in 2010 it had been a clear majority. Polypropylene, probably a sufficient barrier for several months, was encountered in 32 per cent of the packs, mostly for bakery products. Almost half of the packs contained virtually tight barriers.

Numerous producers developed paperboard with internal barrier layers, either coated, e.g. on a printing machine, or laminated with films. The materials used vary from acrylates and cross-linked EVOH to polyamide and polyesters. However, problems remain to be solved. Firstly, it is demanding to apply a tight film onto a rough surface that does not hinder recyclability of the paperboard. Secondly, the cuts, folding and flaps entering the pack compromise the barrier and data is needed to quantify these effects. Nonetheless, presently there are a few products with such paperboard on the market.

## Outlook

Unprotected recycled paperboard has no future in food packaging: while there are strict rules on recycling PET exclusively from food sources and through an efficient cleaning, recycled paperboard is made of virtually any collected waste without significant cleaning. Because of sustainability, it is impossible to do without recycling, particularly for the transport boxes. Functional barriers integrated into the primary packing seem to be the solution.

The German regulation on migrating mineral oils will probably be implemented in the near future, but general requirements on food packaging are sufficient to clarify that improvements are needed. The next steps seem to be establishing methods for measuring barrier efficiencies and standards that define minimum required barrier performance. Guidelines are required to specify for which applications barriers are needed and if so of which minimum efficiency.

**About the Author**

**Koni Grob** began working for the Official Food Control Authority while studying chemistry and undertaking a doctoral thesis in plant physiology. In the 1970/80s, it primarily meant implementing capillary gas chromatography which was then applied for the control of authenticity, e.g., of edible oils. With the migration from can coatings (1996) it became apparent that food contact materials were a neglected field in food safety and probably the largest source of food contamination. Koni works as an expert for various European authorities.