SAFETY OF RECYCLED PAPERBOARD: MINERAL OIL CONTENT DETERMINATION, MIGRATION TO FOOD, AND CLEAN-UP STRATEGIES

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OUTLINES

- MINERAL OIL IN PAPER-BASED FOOD PACKAGING
- EXTRACTIVE AND ANALYTICAL ISSUES
- “SHOPPING TROLLEY” CONTAMINATION SURVEY: RESULTS
- MIGRATION KINETICS FROM PACKAGING TO FOOD: RESULTS
- CLEAN-UP STRATEGIES: PRELIMINARY RESULTS

MINERAL OIL SOURCES:

ENVIRONMENT & FOOD

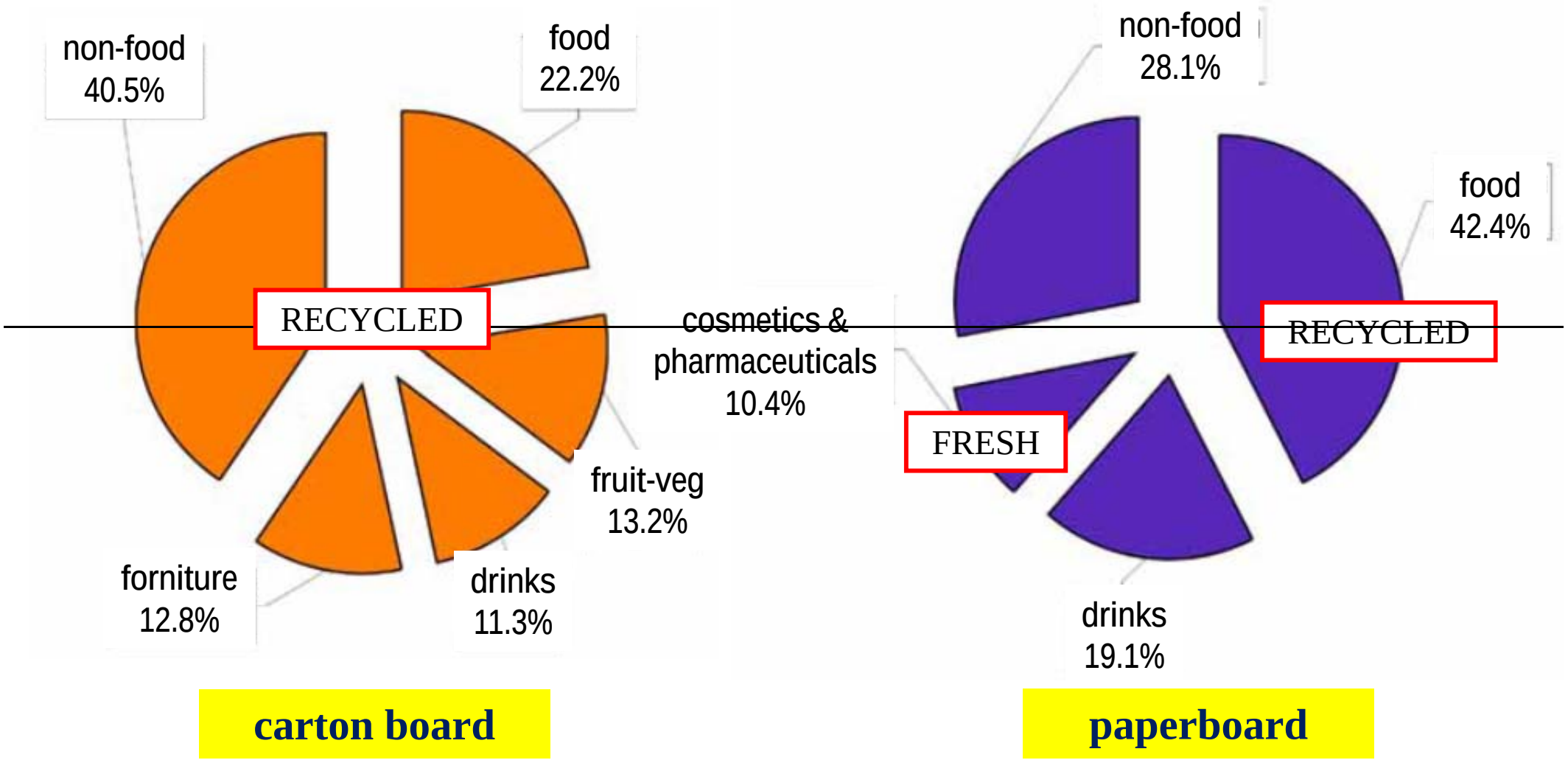
• **ENVIRONMENT:**
SMOG & INDUSTRIAL POLLUTION
TRAFFIC
PETROLEUM SPILLAGES
PESTICIDE FORMULATIONS
COSMETICS

• **FOOD:**
JUTE BAGS BATCHING OIL
BAKERY & SWEETS ANTISTICKING
DUST BINDING
FRUIT & DRIED FRUIT POLISHING
PAPER BASED FOOD PACKAGING

Hydrocarbons are the most abundant xenobiotics in our body (~ 1 g)

(Concin et al., Mineral oil paraffins in human body fat and milk, 2007)

PAPER-BASED PACKAGING DESTINATION



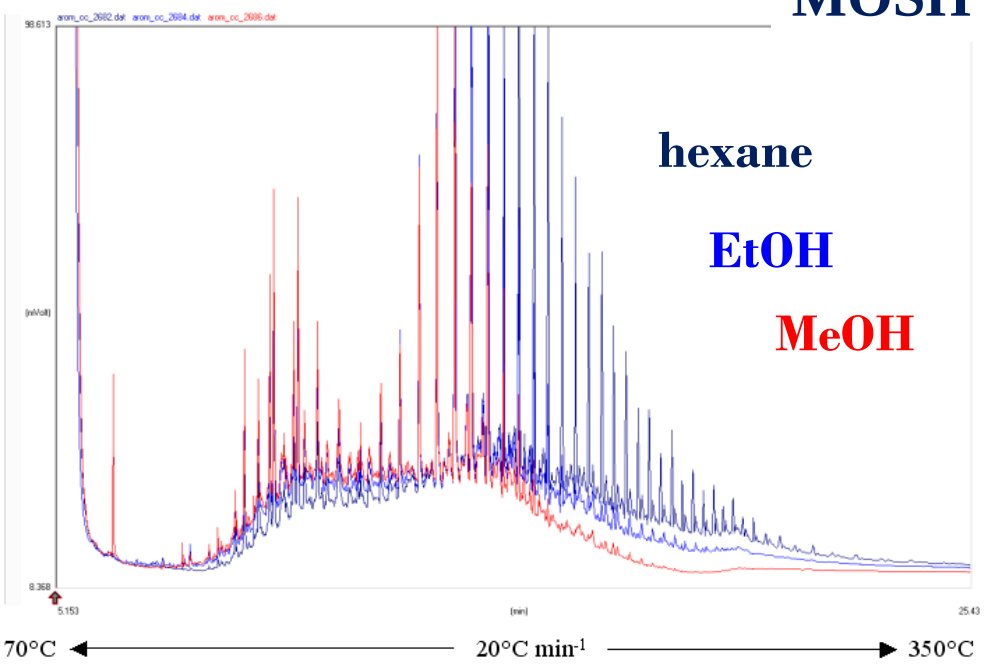
Source: Istituto Italiano Imballaggio, report 2010 on 2009 data

THE ISSUE OF MINERAL OIL IN PAPER BASED PACKAGING FOR FOOD CONTACT

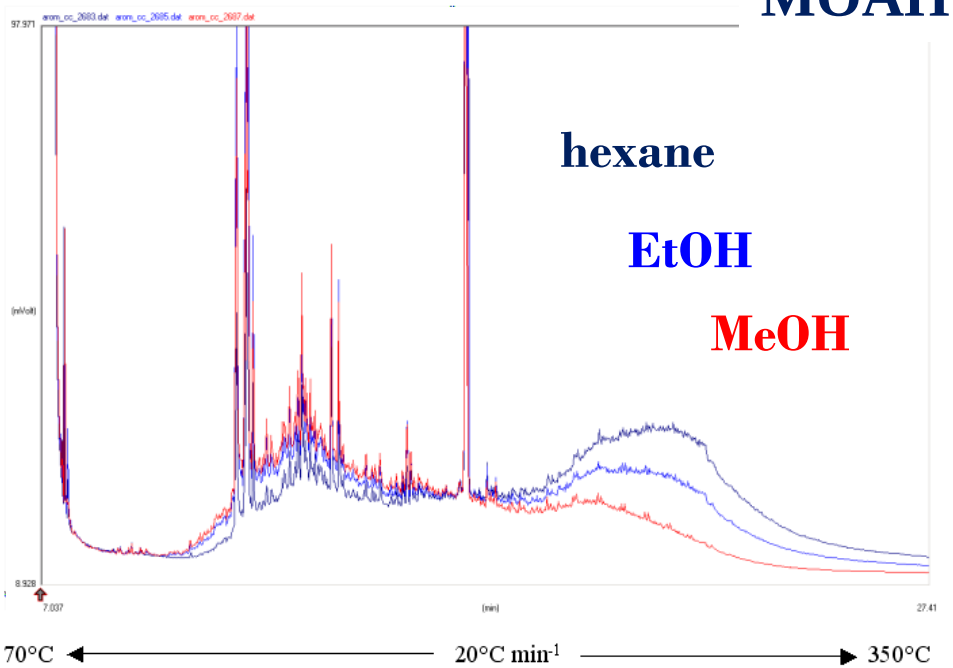
- **LACK OF TOXICOLOGICAL DATA ON HYDROCARBONS**
- **LACK OF RELIABLE ANALITICAL TEST FOR MINERAL OIL CONTENT**
- **LACK OF REGULATORY INTERVENTION**

PAPERBOARD EXTRACTION OPTIMIZATION: RESULTS

MOSH



MOAH



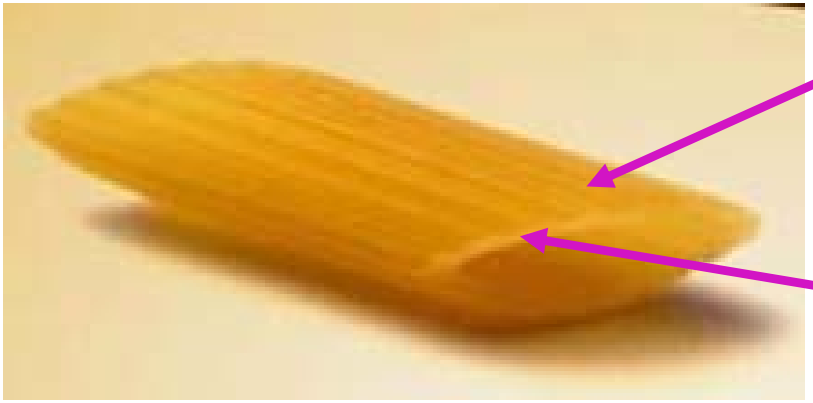
Solvent: Ethanol ideal for low MW & to swell fibres, hexane ideal for medium-high MW

T & time: high T & prolonged contact time extract more hydrocarbons but also more undesired compounds

Ideal: **Ethanol:hexane = 50:50, 2h at RT**

Other extracted: DIPN ("recycling markers") & phthalates

FOOD EXTRACTION OPTIMIZATION: RESULTS



Superficial contamination:

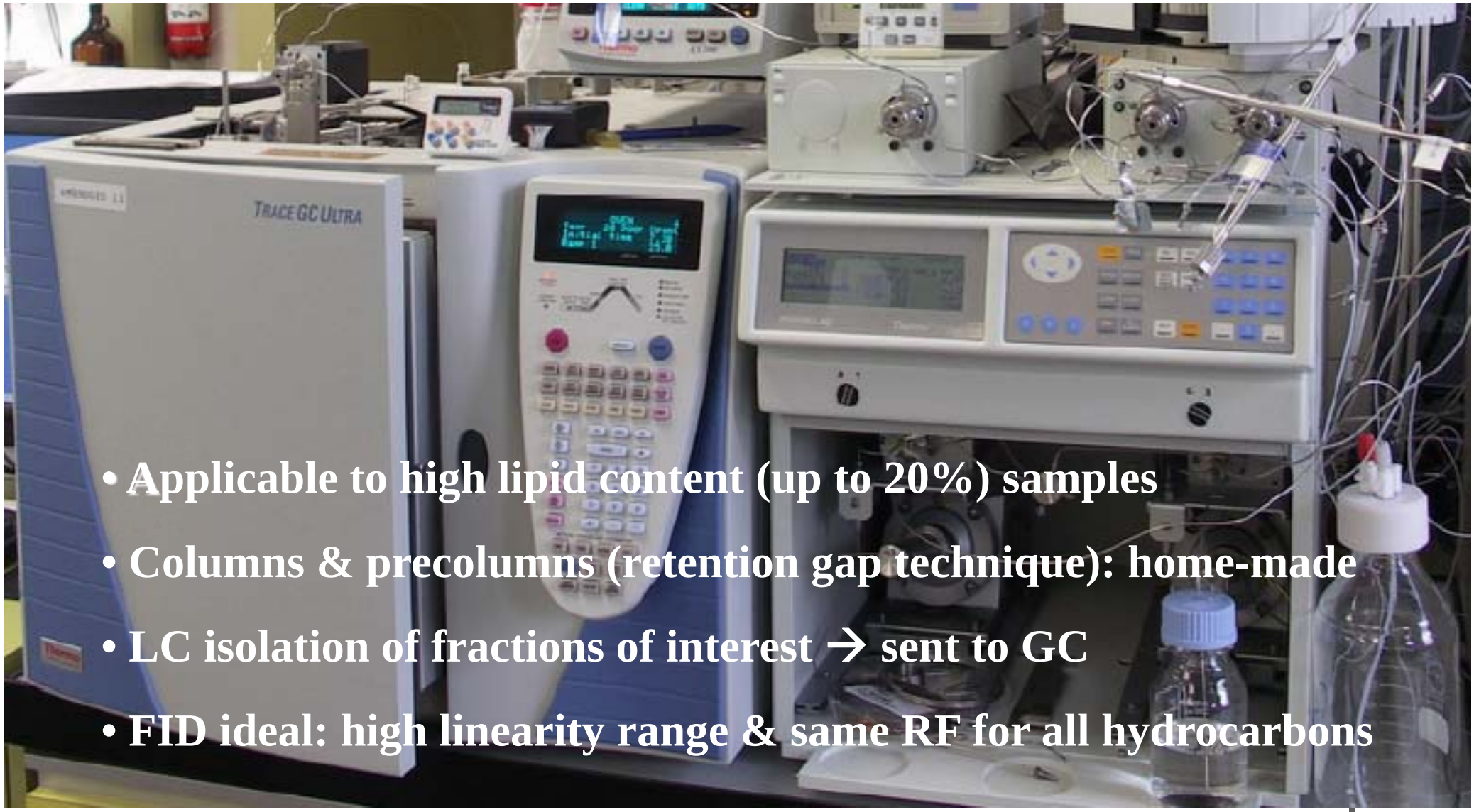
from packaging → hexane is IDEAL

Deep contamination:

pre-packaging → hexane inadequate

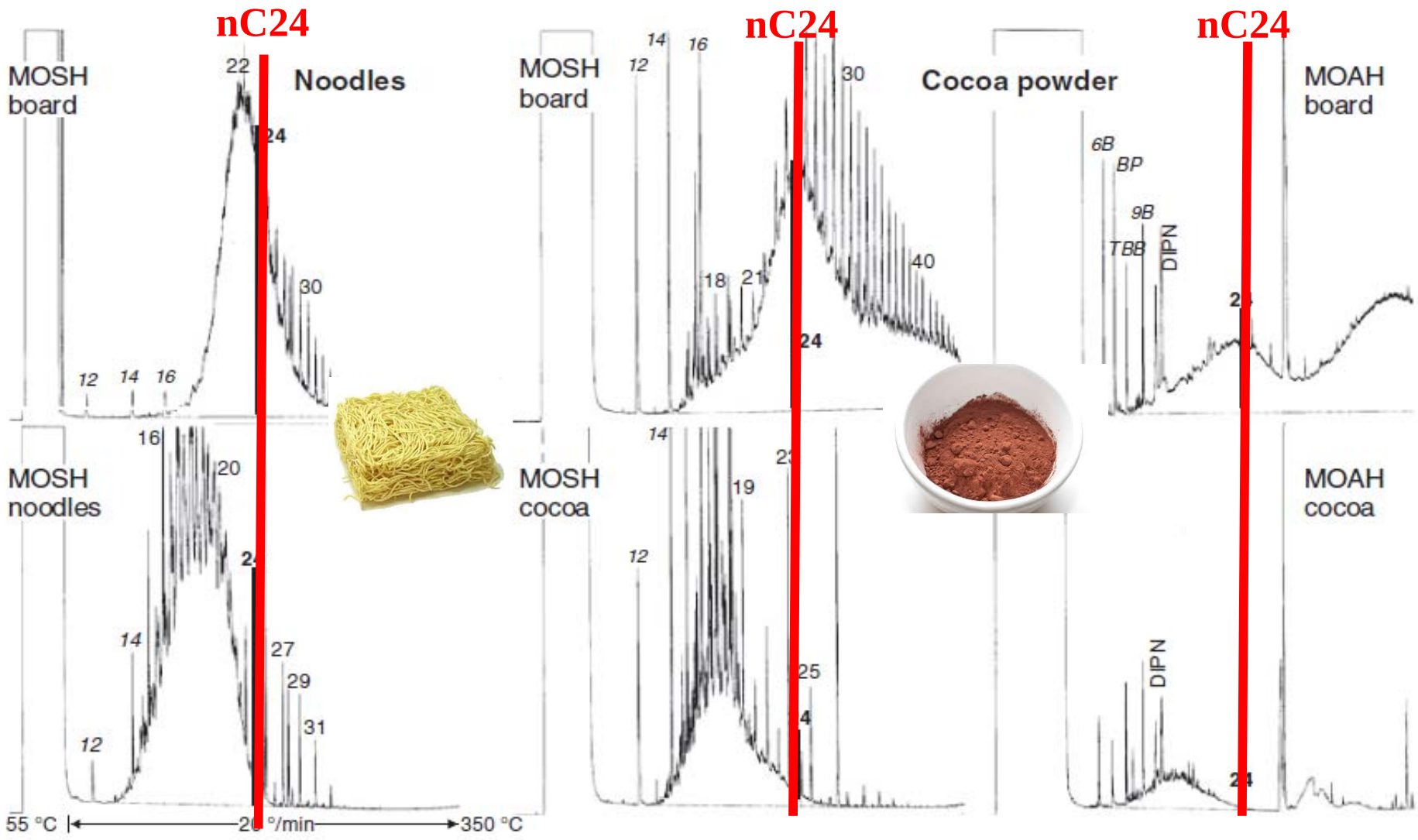
To evaluate deep contamination → preparation of spiked "handmade pasta":

INSTRUMENTAL ANALYSIS:
on line coupled normal phase HPLC-GC/FID



- Applicable to high lipid content (up to 20%) samples
- Columns & precolumns (retention gap technique): home-made
- LC isolation of fractions of interest → sent to GC
- FID ideal: high linearity range & same RF for all hydrocarbons

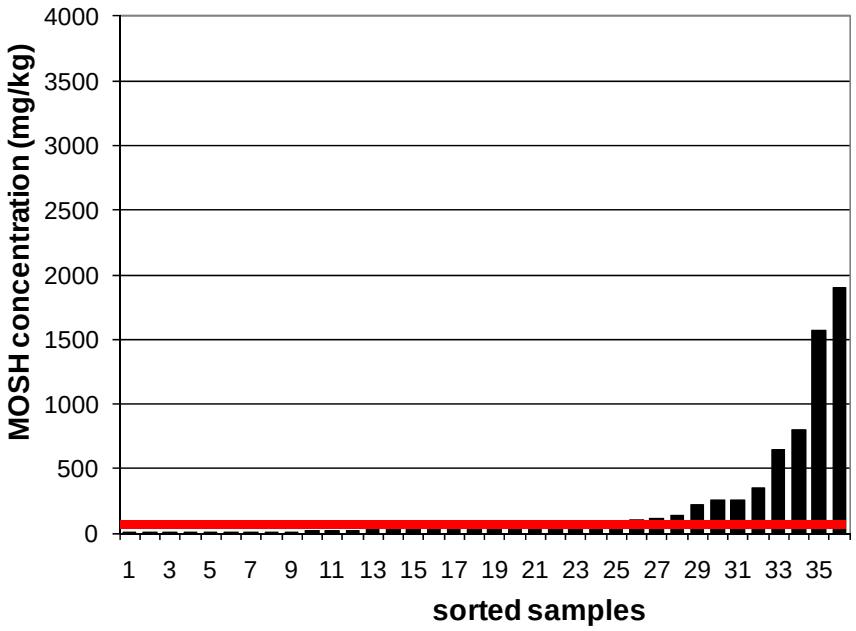
MINERAL OIL MIGRATING FRACTION



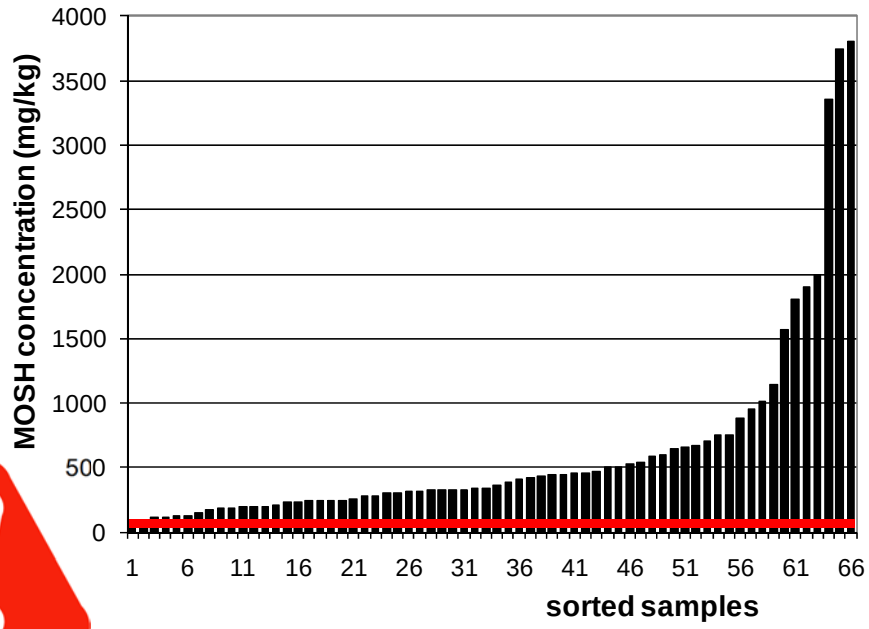
R. Lorenzini *et al.* (2010) *Food Add Contam*, 27(12)1765-1774.

MOSH < nC24 CONTAMINATION: RESULTS

FRESH FIBRES



RECYCLED FIBRES



OPTIONAL SAFETY LIMIT: 4 ppm IN BOARD → < 0.6 ppm IN FOOD

MINERAL OIL MIGRATION KINETICS: RESULTS

CONTROLLED MIGRATION PLAN on

without internal barrier

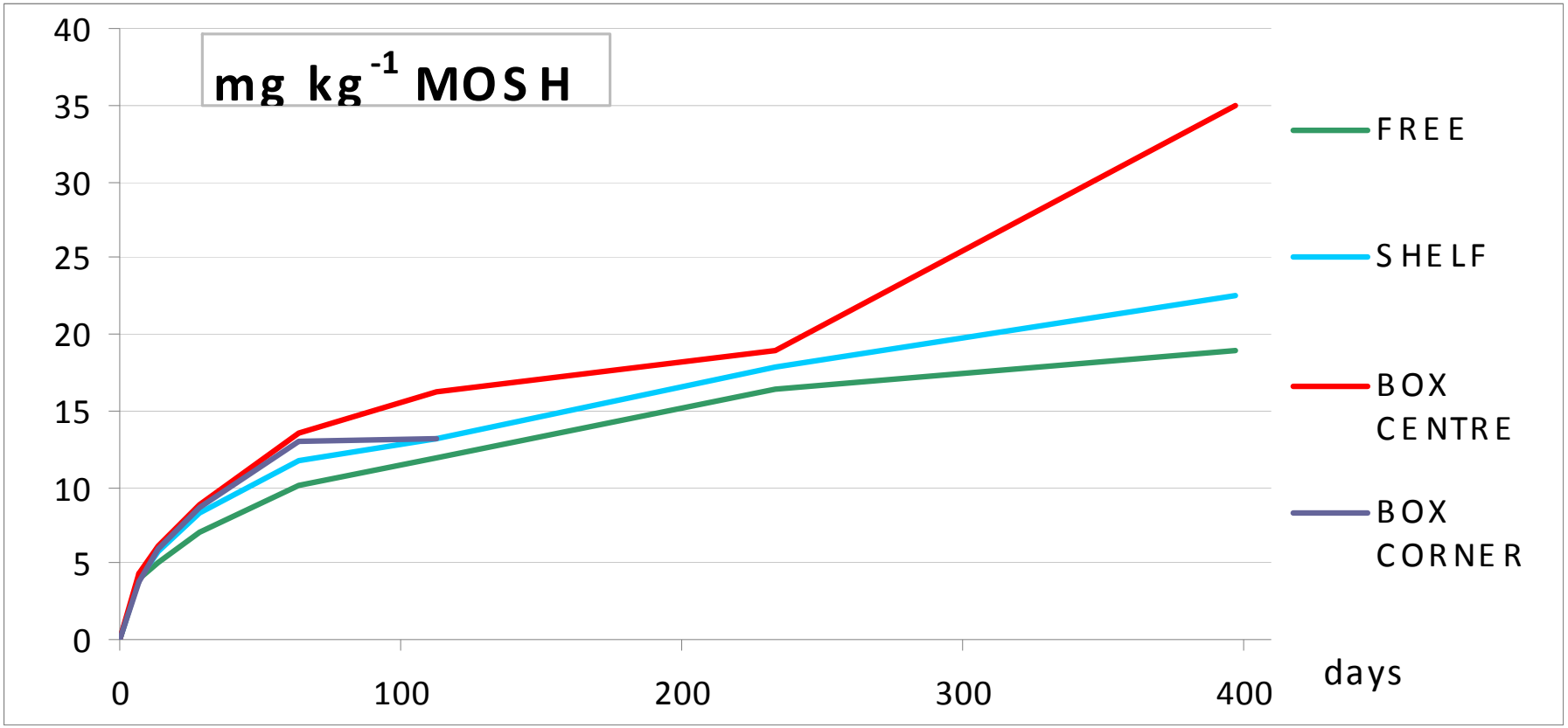
with internal barrier

WAS INVESTIGATED AS A FUNCTION OF

- storage conditions (T, time, position)
- presence of internal bag
- presence of external carton board box

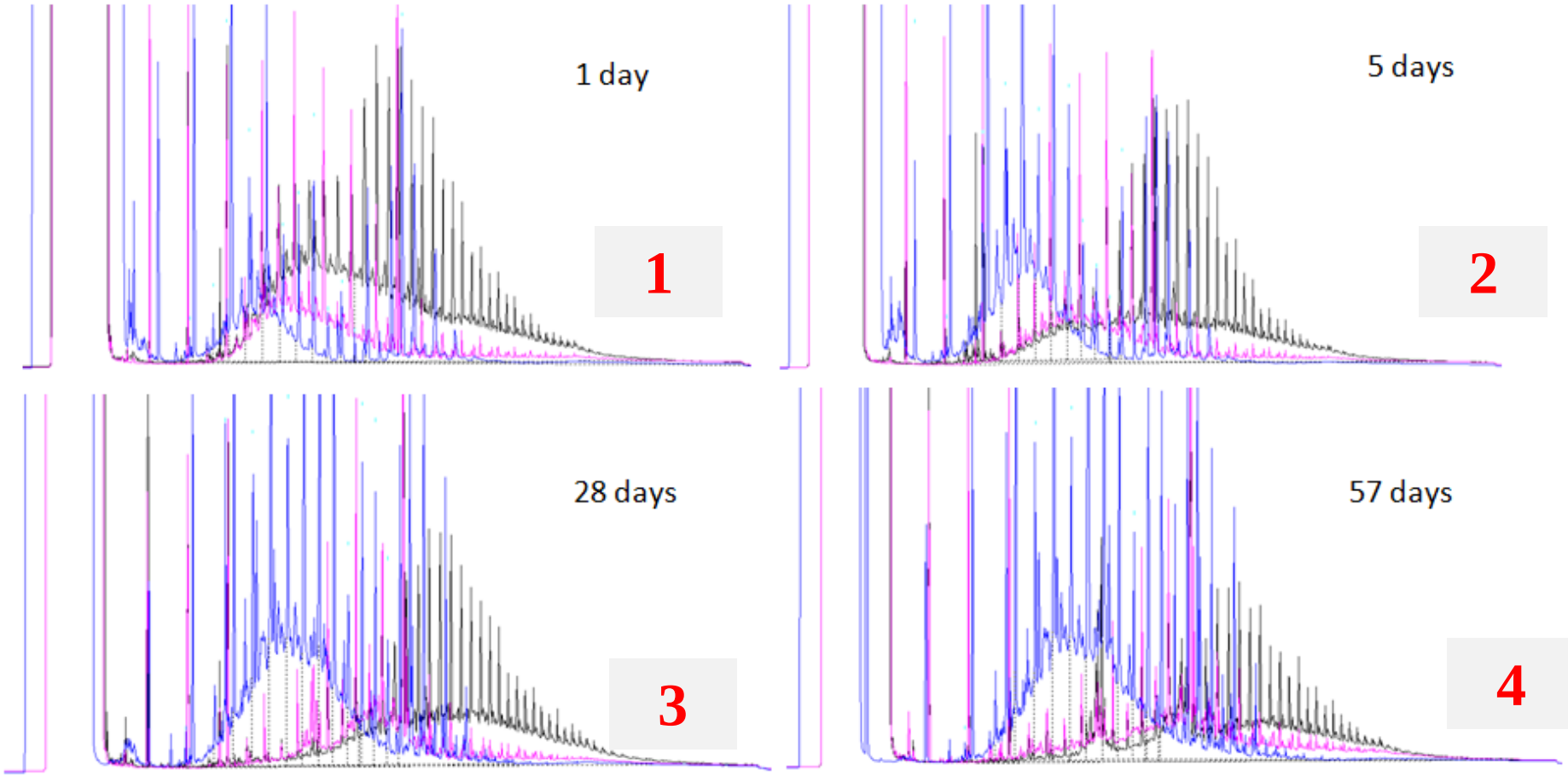
R. Lorenzini et al., (2013) *Food Add Contam*, 4:760-770.

MINERAL OIL CONTENT IN MUESLI UNDER DIFFERENT STORAGE CONDITIONS



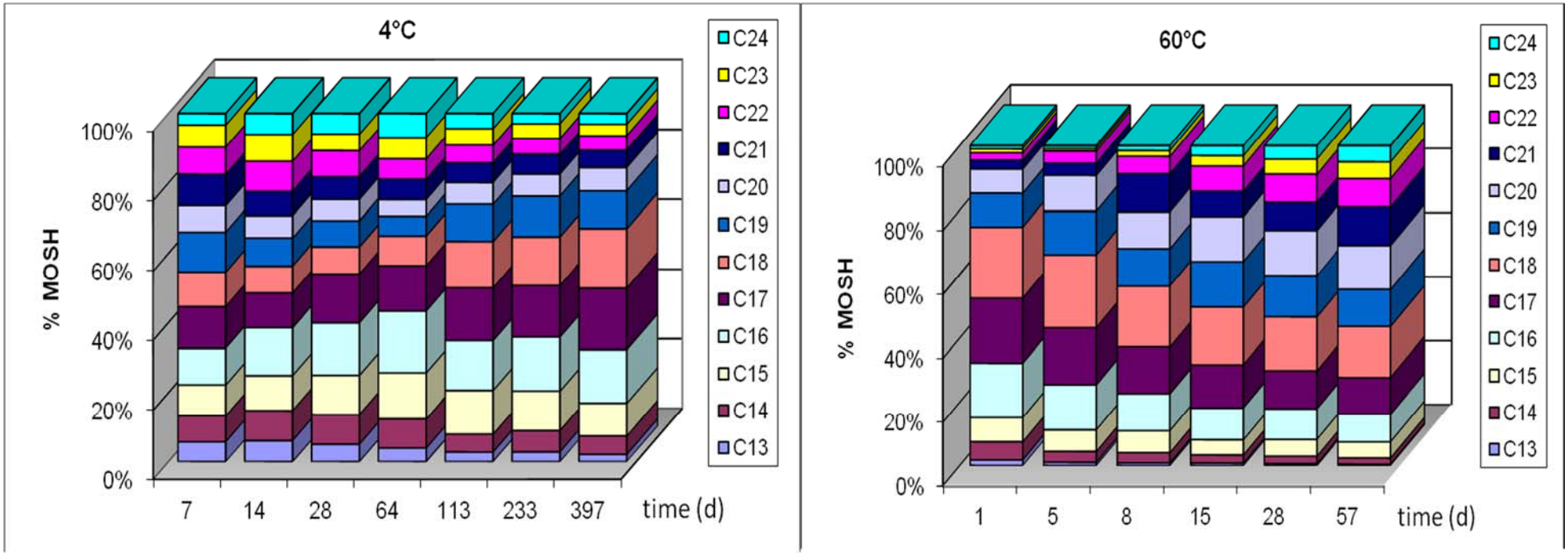
IN BOXED PACKS, MIGRATION CONTINUES UP TO END OF SHELF LIFE (ca. 1 year) REACHING HIGH CONTAMINATION LEVELS

“SPONGE EFFECT” of POLYOLEPHINIC BARRIER



MOSH MIGRATE FROM **PAPERBOARD (BLACK)** TO **PLASTIC (PINK)** AND THEN TO **MUESLI (BLUE)** STORED AT 60°C: PLASTIC BETWEEN PAPERBOARD AND FOOD ACTS AS A STORAGE LAYER FOR CONTAMINANTS.

MINERAL OIL FRACTION SHIFTING UNDER ACCELERATED MIGRATION



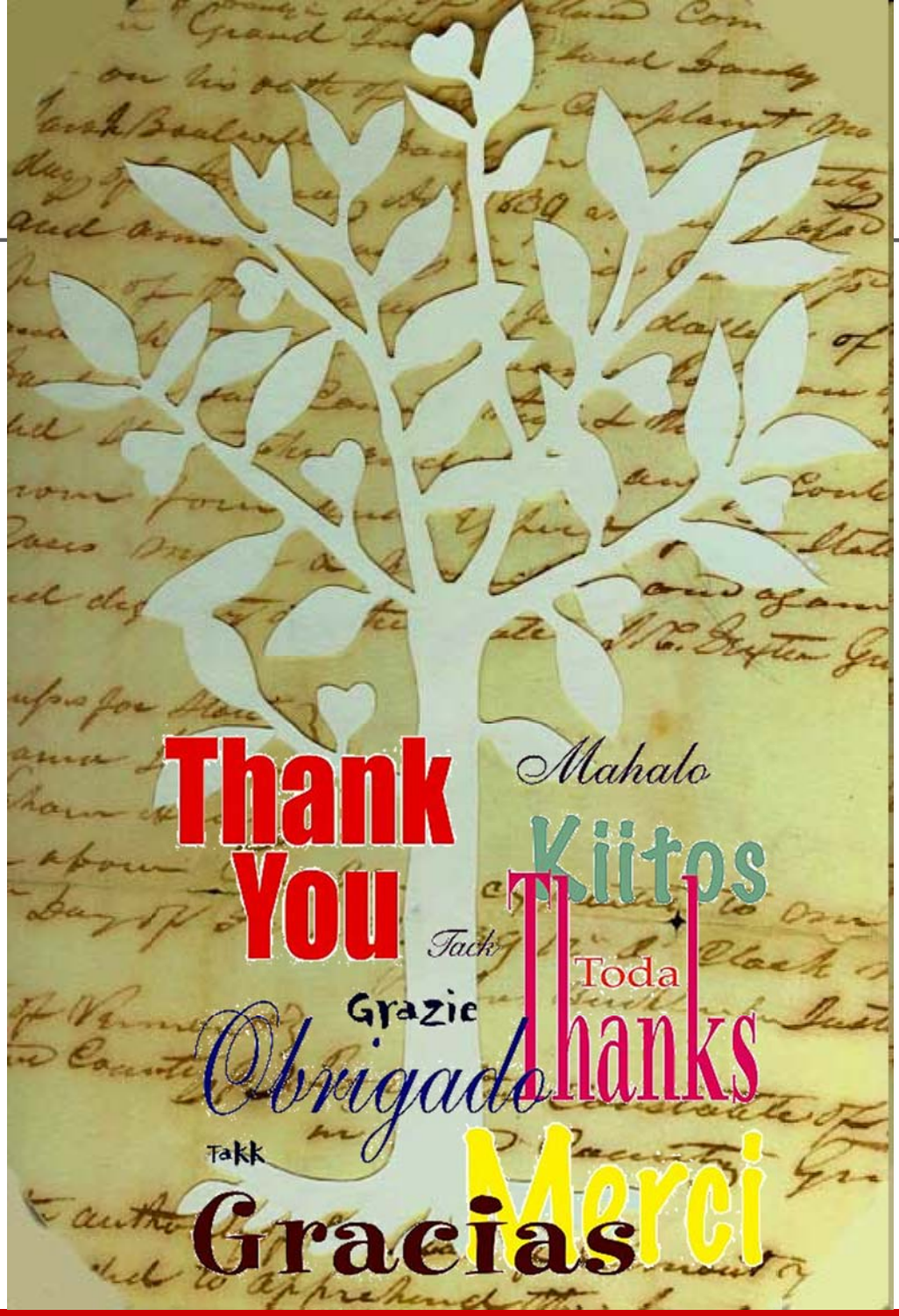
- **HIGHER MW HYDROCARBONS SIGNIFICANTLY MIGRATE ONLY AT HIGH TEMPERATURES**
- **ACCELERATED MIGRATION OVERESTIMATES AND MISREPRESENTS THE REAL MIGRATION PATTERN**

PULP CLEAN-UP STRATEGIES

WASHING

FLOATING

REDUCTION OF THE MINERAL OIL CONTENT OF RECYCLED PAPER BY USING ADDITIVES WITH HIGH AFFINTIY TO HYDROCARBONS (& OTHER POLLUTANTS)
THE ADDITIVES ARE RECOVERABLE AND RECYCLEABLE


Thank You
Mahalo
Kiitos
Tack
Toda
Grazie
Thanks
Obrigado
Takk
Merci
Gracias