

MINERAL HYDROCARBONS IN FOOD CONTACT MATERIALS

Summary

- This survey was carried out to check on the types and amounts of mineral hydrocarbons in materials and articles in contact with food and to quantify the amount of these substances migrating from packaging into food.
- A wide range of mineral hydrocarbons was studied (those with carbon numbers in the range C₁₆ to C₄₀). Substances with carbon numbers C₂₀ to C₃₅ were mainly detected in packaging and food.
- Mineral hydrocarbons were found in 42 out of 64 samples of materials or articles in contact with food. Levels varied depending on the type of packaging. Eighteen out of 30 samples of polystyrene contained 9 to 47 g/kg of oil. Twelve out of 22 samples of waxed paper or board contained 0.4 to 452 g/kg of wax. All twelve samples of corks contained wax at 0.2 to 13 g/kg. Two of these samples of corks also contained oil at 2.1 and 5.7 g/kg.
- Mineral hydrocarbons migrated into food. They were found at up to 31 milligrams (mg)/kilogram (kg) in nine retail samples of food (five of bread and four of confectionery) that had been wrapped in waxed paper. Four cakes baked in a retail sample of waxed paper cases contained a mean level of 29 mg/kg of mineral hydrocarbons, the level being higher in the cake surface than in its centre. There was also evidence of oil left over after the manufacture of skinless sausages (5 out of 8 samples contained 2 to 28 mg oil/kg) and cans (1 out of 26 samples of canned food and beverages contained 8 mg/kg of oil).
- Migration of mineral hydrocarbons into food is not a health concern. Consumer intakes of wax and oils migrating into food were within ranges of Acceptable Daily Intakes set by the European Union's Scientific Committee for Food and Joint FAO/WHO Expert Committee on Food Additives.

Background

Mineral hydrocarbons may be present in food from a number of sources, including:

- their migration from some types of packaging;
- as a natural component;
- from their presence in the environment; and
- from their use as lubricants in processing machinery.

This survey was carried out to check on the types and amounts of mineral hydrocarbons in materials in contact with food and to quantify the amount of these substances migrating from packaging into food. The first step in the survey was to establish the levels and carbon distributions of mineral hydrocarbons in the packaging materials.

Food samples were tested either:

- where mineral hydrocarbons were found at such levels in packaging as to indicate probable food contamination; or
- carbon distributions were apparently different from those specified in law.

Mineral hydrocarbons in the carbon number range C_{16} to C_{40} were studied by gas chromatography-flame ionisation detection (GC-FID). Internationally established specifications for these substances are understandably broad, although there is evidence that mineral hydrocarbon deposition in animal tissues indicates that this may be limited to mineral hydrocarbons in the range ca. C_{20} to C_{35} .¹⁻³

There has been quite extensive research but little or no surveillance work on mineral hydrocarbons in materials in contact with food. In 1991, Grob *et al.* reported food contamination by hydrocarbons from lubricating oils and release agents, used during food manufacture. Bread, bonbons and chocolate were analysed and levels approached or exceeded one per cent weight/weight.⁴ Grob *et al.* also looked at food contamination by hydrocarbons from packaging materials such as sisal bags, cardboard boxes, plastic films, wax-coated paper and cardboard as well as paraffin coatings. Food contamination was found at concentrations up to several thousand mg/kg, more than half of which was believed to be due to the packaging material.⁵ Research by Castle *et al.* provided further evidence that mineral hydrocarbons may migrate from packaging into food and drink.⁶⁻¹¹

The use of mineral hydrocarbons in plastic packaging materials is subject to Commission Directive 2002/72/EC relating to plastic materials and articles intended to come into contact with foodstuffs.¹² However, these controls do not include surface coatings obtained from:

- paraffin waxes, including synthetic paraffin waxes and/or micro-crystalline waxes; or
- mixtures of the particular waxes listed above with each other and/or with plastics.

Thus waxed coatings on paper and board are not included in this legislation. There is not a specific Directive for paper and board, nor are there specific Directives for the other, non-plastic materials investigated in this survey. Where there is no specific food contact legislation, Article 2 of Council Directive 89/109/EEC applies.¹³ The Materials and Articles in Contact with Food Regulations 1987, as amended, brought this Directive into force in this country. The Mineral Hydrocarbons in Food Regulations 1966, as amended, prohibit the use of any mineral hydrocarbons (subject to certain exceptions relating to their presence in lubricants, chewing compounds, the rind of cheese and use as a miscellaneous additive) in the composition or preparation of food or the sale of food.¹⁴

Mineral hydrocarbons have been reviewed by international expert committees. The European Union's Scientific Committee for Food (SCF)'s opinion on mineral and synthetic hydrocarbons concluded that there were sufficient data to allocate a full group Acceptable Daily Intake (ADI) of 0 - 20 mg/kg bodyweight for waxes with the specification given below.¹⁵ This ADI is the same as that set by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) for microcrystalline and high sulfur-containing waxes.¹⁶ The specification used by the SCF was as follows:

Highly refined waxes derived from petroleum based or synthetic hydrocarbon feedstocks, with:

Viscosity	not less than 11 centistokes at 100 °C
Carbon number	not less than 25 at the 5 per cent boiling point
Average molecular weight	not less than 500

ADIs have also been set by the SCF for specified mineral oils at 0 - 4 mg/kg bodyweight, and by JECFA at 0 - 1 mg/kg bodyweight for specified mineral oils of paraffinic origin and 0 - 0.1 mg/kg bodyweight for specified mineral oils of naphthenic origin.^{15,16}

Methodology

Samples and timing

There are no major regional variations in the use of mineral hydrocarbons in materials and articles in contact with food across the UK. Therefore samples were obtained in one part of the country. One hundred and seven samples (Table 1) were purchased in triplicate in northern England in November and December 2001. Analytical work was completed in October 2002. The results were collated, checked and reviewed in November and December 2002.

A wide variety of different samples was obtained:

- foods packed in polystyrene containers, 30 samples;
- foods packaged in wrapped in waxed paper or board, 22 samples;
- wine in glass bottles with cork stoppers, 12 samples;
- food and beverages in metal cans, 26 samples;
- foods packaged in cartonboard boxes glued with hot-melt adhesives, 9 samples; and
- skinless sausages, 8 samples.

About 80 per cent of the samples were purchased from national supermarket chains. The ratio between branded goods and stores' own brands was about 70:30. Each sample was assigned a unique code number. Samples were stored at ambient temperature (approximately 20°C away from sunlight), in a refrigerator (less than 10°C) or in a freezer (-20°C) as appropriate, until their best before date or one month after purchase, whichever occurred first. The packaging and any food product were then separated, overwrapped in aluminium foil, and stored separately in a freezer (-20°C) to prevent any cross-contamination.

All samples were analysed by the Central Science Laboratory, Sand Hutton, York. The analytical methods used were based on those previously published for the determination of mineral hydrocarbon oils and waxes in food contact materials and foods.⁶⁻¹¹

Standard solutions

Authentic alkanes with carbon number ranges C₁₆ to C₃₀, C₃₂ to C₃₄, C₃₆, and C₄₀ were prepared as a mixed solution (0.1 g/L of each component in hexane). An *n*-alkane internal standard mix contained C₁₆, C₂₀, squalane, and C₄₀ (500 mg/L in hexane). Solutions of

N70H and N15H mineral oil standards were produced in hexane at 3 g/L. A solution of low melting point wax (LMPW) standard was prepared at 0.2 g/L in hexane. These standard solutions were stored at +4°C and allowed to warm to room temperature, with a visual check against possible precipitation, before use. Other standard solutions were prepared from these by dilution as required.

Analytical method

Overview

Hexane was used to extract mineral hydrocarbons from the survey samples. Non-polar aromatic or olefinic co-extractives were removed by alkaline permanganate oxidation followed by 'clean-up' on a silica cartridge. For very fatty foods, the content of co-extracted fat was reduced by saponification before the oxidation step was done.

Food samples were split and analysed in duplicate, to check for possible variations in recovery between different types of food. One part of each sample was analysed 'as is' and the other part was 'spiked' with a known quantity of mineral oil or wax. The internal standard mix of *n*-alkanes was added to every sample before extraction, to aid the quantification of results.

Extraction of packaging samples

Samples were extracted as described below. The extracts were then dried under nitrogen and 'cleaned up' by oxidation/solid phase extraction.

Extraction of mineral hydrocarbons from polystyrene packaging

A weighed portion of the packaging (0.05 g) was placed in a vial together with internal standards (0.05 mg of each). Chloroform (0.5 mL) was added to dissolve the polystyrene followed by the dropwise addition of hexane (2 mL, with swirling) to separate out the polymer by precipitation.

Extraction of mineral hydrocarbons from waxed paper and board packaging

Samples of paper or board (0.1 g) or papers from individual sweets were measured for area, weighed into a vial and then extracted by shaking overnight in hexane (5 mL) containing internal standards (0.05 mg of each).

Extraction of mineral hydrocarbons from cork stoppers

A slice of ca. 5 mm was cut from the top surface, weighed and placed in a 20 mL vial. The cork slice was extracted by shaking overnight with hexane (5 mL) containing internal standards (0.05 mg of each).

Extraction of hot melt adhesives

The hot melt adhesive was sliced off the packaging using a scalpel. A weighed portion (0.05 g) was placed in a vial and then extracted by shaking overnight in hexane (5 mL) containing internal standards (0.05 mg of each).

Preparation of cake samples

A packet sponge cake mix was used to determine migration into cakes from a sample of baking cases. The stated composition of the cake mix was 12.7 per cent fat content (dry weight) and the on-pack instructions were to add one medium-sized egg to 150-250 g of dry mix. Cakes were cooked in the paper cases for 14 minutes at 190 °C. They were allowed to cool on a wire rack overnight and then unwrapped by hand.

Extraction of food samples

Extraction of mineral hydrocarbons from canned foods

The cans' entire contents were homogenised using an Ultra-Turrax[®] homogenizer and then divided into two equal, weighed portions. One portion was analysed 'as is'. To the other portion a known amount of N70H mineral oil was added as a 'spike'. Hexane was added (50 to 250 mL) as required to give a clear phase separation and the mixture extracted by homogenising for 1 minute. The two phases were allowed to separate and the upper hexane phase transferred into a round-bottom flask. The food slurry was extracted with a further portion of hexane. The combined extract was evaporated to dryness using a Rotavapor[®] and the residue determined gravimetrically. When a quantity of co-extracted fat was obtained, this was hydrolysed by refluxing with 60 per cent potassium hydroxide in water (5 mL/g fat) and ethanol (15 mL/g fat) for 3 hours. Water was then added (10 mL/g fat) and the mixture extracted with hexane (3 x 50 to 100 mL, as required to give clear phase separation). The combined extract was filtered through anhydrous sodium sulfate (10 g), evaporated to dryness, and 'cleaned up' by oxidation/solid phase extraction.

Extraction of mineral hydrocarbons from ice cream, chicken and sweetcorn

Ice cream, chicken and sweetcorn were homogenised using an Ultra-Turrax[®] homogenizer and then divided into two equal, weighed portions and extracted as described above for canned foods.

Extraction of mineral hydrocarbons from bread, cakes or oats

Bread, cakes or oats were homogenised in a food blender for approximately 5 minutes. One portion (10 g) was taken for analysis 'as is' and a second portion (10 g) was 'spiked' with low melting point wax. Hexane (100 mL) was added and the mixture homogenised using an Ultra-Turrax[®] homogenizer. The extract was filtered and then evaporated to dryness using a Rotavapor[®] and 'cleaned up' by oxidation/solid phase extraction.

Extraction of mineral hydrocarbons from canned beverages

The can contents were poured into a beaker and degassed (if carbonated) using an ultrasonic bath for 15 minutes. The sample was divided into two weighed portions and one was 'spiked' with N70H mineral oil. Each portion was extracted in a separating funnel with hexane (3 x 100 mL). The combined extract was filtered through anhydrous sodium sulfate (5 g), evaporated to dryness, and 'cleaned up' by oxidation/solid phase extraction.

Extraction of mineral hydrocarbons from sweets, chews and wine

Sweets and chews were dissolved in an aliquot of water. These and wine samples were then extracted as described above for canned beverages.

Extraction of mineral hydrocarbons from sausages

Sausages were mixed in a bowl using a metal spoon. A portion (ca. 20 g) was then dried in an oven overnight at 80°C. The dry weight was recorded. The meat was powdered using a glass rod and then two portions (5 g) were taken. One was 'spiked' with N70H mineral oil. The sample was refluxed for ca. 2 hours with 60 per cent potassium hydroxide solution (25 mL) and ethanol (75 mL). Water was then added (50 mL) and the mixture extracted with hexane (2 x 50 mL). The combined hexane extract was washed with water (3 x 10 mL), dried over sodium sulphate, filtered, evaporated under nitrogen, and 'cleaned up' by oxidation/solid phase extraction.

'Clean up' by oxidation/solid phase extraction

Permanganate oxidation

Potassium hydroxide (1 mL, 14 g/l) and potassium permanganate (1 mL, 60 g/l) were added to dried-down extract. The mixture was heated at 80°C for 90 minutes with occasional shaking and then extracted with portions of hexane (3 x 1 mL).

Solid phase 'clean-up' on silica cartridge

The extract was evaporated and made up to a final volume of 1 mL in hexane. A silica cartridge (500 mg, 3 mL capacity) was pre-conditioned with 3 mL of hexane. The extract was then transferred to the cartridge and any eluate collected in a vial. Further hexane (2 mL) was applied to the cartridge and the eluate collected. Finally, any solvent remaining in the cartridge was collected under vacuum into the same vial. The extract was made up to a final volume of 5 mL with hexane.

Gas chromatographic analysis

Sample extracts were analysed by GC-FID (gas chromatograph fitted with a flame ionisation detector) using a Carlo Erba HRGC 5300 Mega series, under the following conditions:

Column:	Chrompak CPSil 5CB, 5 metres x 0.25 millimetres internal diameter, 0.25 micrometre film thickness of a methyl silicone phase
Carrier gas:	Helium at 1.0 mL/minute (min.) at 315°C
Purge gas:	Helium at 1.5 mL/min.
Autosampler:	Carlo Erba A200S
Injection volume:	1 microlitre split 20:1
Injection temperature:	250°C
Detector temperature:	320°C
Oven programme:	120°C hold 5 min. Raise to 315°C at 20°C per min. Hold for 5 min.

Identification and quantification of hydrocarbon waxes

Alkane peaks in the sample chromatogram were identified by comparison with the retention time of *n*-alkanes in the standard solution. Analysis of the standard solution

showed that the relative response factor for *n*-alkanes in the range C₁₆ to C₄₀ was unity. Therefore *n*-alkanes in samples were quantified by a direct comparison of their peak areas with those of the internal standards used.

Identification and quantification of hydrocarbon oils

For extracts that demonstrated a characteristic mineral oil plateau in the GC-FID chromatogram, a baseline was extrapolated under the peak and the total area of the peak recorded. This area was used to calculate the amount of mineral oil in the extracted sample.

Calculation of average carbon number and carbon number distribution

The total peak area of the GC-FID response to the wax or oil distribution was recorded. Using the electronic integration system, a cursor was moved along the baseline of the chromatogram until 50 per cent of the total peak area lay either side of the cursor (i.e. at higher and lower retention times). The retention time at this point was then converted into an effective carbon number by interpolation of the curve of retention time versus carbon number of the *n*-alkane standards in the range C₁₆ to C₄₀. This gave the average carbon number (i.e. 50 per cent by mass either side) of the mineral hydrocarbon distribution. A similar procedure was used to establish the carbon number at the 5 per cent and 95 per cent cut-off points.

To establish the fraction of hydrocarbon below a given carbon number value (e.g. mass per cent less than C₂₅), the cursor was moved along the baseline of the chromatogram to the retention time of the target carbon number (e.g. C₂₅). Then the area below that point (lower carbon number) was expressed as a percentage of the total GC-FID peak area.

Calibration of the GC-FID system could only be carried out using reference *n*-alkane standards because a comprehensive collection of branched and cyclic isomers of alkanes covering the carbon number range of interest could not be obtained. For individual *n*-alkanes the accuracy of the method was absolute, that is a substance either has 24 or 25 carbons. For *n*-alkane distributions the assignment was good to ± 0.1 . For waxes and oils that contain branched and cyclic hydrocarbons the calibration against *n*-alkanes was not perfect as the *iso*-species elute earlier than their *n*-alkane counterparts. Hence the average carbon number measured by this method may be 1 to 2 carbon numbers less than the actual average carbon number of the wax or oil. The exact difference depends on

the degree of branching.¹⁷ Conversely, cyclic alkanes elute just after an *n*-alkane of the same carbon number. To allow for these effects the measured carbon number was adjusted by +2 for all the results.

Gravimetric analysis

The hexane extract from some samples was evaporated to dryness and weighed after extraction to determine the total amount of mineral hydrocarbon present. This included high molecular weight mineral hydrocarbons which were not detectable by GC-FID. These gravimetric data were used to adjust the carbon number distributions obtained from the GC-FID analyses. The GC-FID method had a practical upper limit of C₅₀ because mineral hydrocarbons with carbon numbers greater than 50 were not sufficiently volatile to be analysed by this method.

Quality assurance

Internal quality control

Samples were analysed in batches, typically 10 to 15 samples. Each analytical batch included at least three method blanks and two 'spiked' samples.

Check sample exercise - test for accuracy

To demonstrate the accuracy of the analysis, six samples each of bread crumbs (10 g) and yoghurt (70 g) were 'spiked' with mineral hydrocarbons so that they could be analysed 'blind' as a check on both methodological accuracy and the ability to distinguish between different types of oils and waxes. The hydrocarbon mixtures used were as follows:

- N70H mineral hydrocarbon oil (a food grade mineral oil);
- Motor engine oil;
- Low melting point wax (LMPW) (a food grade wax);
- Candle wax; and
- Hexane (for 'blank' samples).

The yoghurt was 'spiked' with mineral oil because yoghurt is commonly packaged in polystyrene that might contain mineral oil. Breadcrumbs were 'spiked' with mineral wax because bread can be packaged in waxed paper. The N70H oil and the LMPW were available from earlier studies.⁶⁻¹¹ The engine oil and the candle wax were household products.

Samples were prepared at the School of Health Sciences, Sunderland University for 'blind' analysis at CSL, York. CSL correctly identified the blank and 'spiked' samples, and the types of mineral hydrocarbon used, and measured their levels to a satisfactory degree of accuracy (Table 2).

Reporting

Analytical recovery

All results reported for this survey are corrected both for background levels of mineral hydrocarbons in blanks and for recovery. 'Spiked' samples of polystyrene (N70H oil, 3 per cent), paper (*n*-alkanes, 500 mg/kg) and cork (*n*-alkanes, 68 mg/kg) were analysed. The analytical recovery was in the range 96 to 104 per cent and the relative standard deviation for the analysis ($n=7$) was 2 to 6 per cent. Six different types of food were 'spiked' for recovery tests. These were: yoghurt (N70H oil, 107 mg/kg), bread (LMPW, 30 mg/kg), sweetcorn (LMPW, 2.5 mg/kg, plus N70H oil, 105 mg/kg), baked beans (LMPW, 2 mg/kg, N70H oil, 84 mg/kg) wine (LMPW, 5 mg/kg plus N70H oil, 120 mg/kg) and sausages (N70H oil, 120 mg/kg). The analytical recoveries for the first five food types fell in the range 80 to 106 per cent and the relative standard deviation figures ($n=6$ or 7) were in the range 9 to 13 per cent. The 'unspiked' sausages already contained some oil before 'spiking'. This was allowed for by subtraction from the respective analytical results. But this correction may explain why the recovery value was lower than for the other foods tested (41 per cent with a relative standard deviation [$n=7$] of 5 per cent).

The calibration of standards of mineral oil (N70H) was linear over the range 0 to 1500 mg/L ($r^2=0.9981$ or greater). The analysis of *n*-alkane standards in the range C₁₆ to C₄₀ was linear over the concentration range 0 to 300 mg/L ($r^2=0.9994$ or greater).

Establishing the limit of detection (LoD) for analysis took into account a requirement to detect and identify any mineral hydrocarbons found by measuring the carbon-number distribution. The LoD for oil in polystyrene was 0.5 per cent weight/weight (5 g/kg). The LoD for individual wax hydrocarbons in paper and board was 25 mg/kg. The LoD for oil in cork and in hot-melt adhesive was 20 mg/kg (for individual *n*-alkane hydrocarbons: 1 mg/kg). The LoD for food analysis was 2 mg/kg for oil and 0.3 to 0.5 mg/kg for individual wax hydrocarbons.

Brand names were reported as this survey was carried out in accordance with guidelines for reporting survey results published in the *Food Safety Information Bulletin* in September 1997. The absence of a particular brand from Tables 1 and 3 to 8 means only that the brand was not included in the survey.

Results and interpretation

Mineral hydrocarbons were found in 42 out of 64 samples of materials or articles in contact with food. Levels varied depending on the type of packaging. Eighteen out of 30 samples of polystyrene contained 9 to 47 g/kg of oil (Table 3). Twelve out of 22 samples of paper or board contained 0.4 to 452 g/kg of wax (Table 4). All twelve samples of corks contained wax at 0.2 to 13 g/kg (Table 5). Two of these cork samples also contained oil at 2.1 and 5.7 g/kg.

Adhesives from nine samples of cartonboard did not apparently contain mineral hydrocarbons. Although five of these samples gave GC peaks, these were narrower than 'peaks' for mineral oils. Three of these five samples gave two or more discrete peaks. It was concluded that the material was not a mineral oil but was more likely to be a synthetic component of the adhesive. The Agency plans to commission further work into chemical migration from adhesives used in food contact materials and articles. Work to identify the peaks seen here would be undertaken as part of that project.

Mineral hydrocarbons migrated into food. There was evidence of oil being transferred in the manufacture of skinless sausages (5 out of 8 samples contained 2 to 28 mg oil/kg; Table 6), and in the production of cans (one out of 26 samples of canned products contained 8 mg/kg of oil; Table 7). Waxes were found at up to 31 mg/kg in nine retail samples of food (five of bread and four of confectionery) that had been wrapped in waxed paper (Table 8). There was also migration of wax into cakes: four cakes were baked using a retail sample of waxed paper cases. A mean level of 29 mg/kg of mineral hydrocarbons was found in whole cakes. The levels of mineral hydrocarbons were higher in the cake's surface than in its centre (Table 9). Eleven per cent of the total wax in the paper cases transferred to the cake. This value is not surprising considering the fatty nature of cake mix and the high temperatures involved in the cooking process.

The migration of mineral hydrocarbons into food is not a health concern. Consumer intakes of both waxes and oils migrating into food would be within the ranges of Acceptable Daily Intakes (ADIs) set by the EU Scientific Committee for Food (SCF) and Joint FAO/WHO Expert Committee on Food Additives (JECFA). Wax intakes from food samples tested in this survey were estimated as up to 0.18 mg/kg bodyweight/day for adults and up to 0.37 mg/kg bodyweight/day for toddlers. Intakes of oils from food samples were estimated as up to 0.024 mg/kg bodyweight/day for adults and up to 0.096 mg/kg bodyweight/day for toddlers. These worst-case estimates were made using:

- the National Diet and Nutrition Survey (NDNS) data bank and a custom-made Food Standard Agency exposure assessment computer programme; where there was not a specific product category, the more general one was taken which would lead to an over-estimation
- only the results for samples where oil or wax was found, and hence not allowing for any dilution in the diet of mineral hydrocarbon contamination;
- maximum levels of oil found in skinless sausages and canned food from Tables 6 and 7;
- migration data (maximum concentrations) for samples wrapped in waxed paper (Table 8) and a mean value of 29 mg/kg for wax levels in four cakes cooked in baking cases;
- 97.5 percentile values from dietary surveys for daily consumption of foods into which wax had migrated; ^{18,19} and
- mean values of bodyweight: 70.1 kg for an adult and 14.5 kg for a toddler. ^{18,19}

The above estimates of intake were less than a figure for overall daily ingestion of mineral hydrocarbons from packaged food in the USA (0.875 mg/kg bodyweight/day) estimated by Heimbach *et al.* from food-use applications.²⁰

Surprisingly little can be done with the carbon number distributions measured in this survey. In particular meaningful comparison of carbon number data with specifications is apparently fraught with difficulties. There were differences in the carbon number ranges covered by GC-FID and gravimetric analysis. For example in Table 4 the gravimetric results for percentage carbon numbers less than C25 and less than C35 were lower than the results from GC-FID. There were differences between the quantities of hydrocarbon wax determined by GC-FID and gravimetric analysis (for samples other than no. 64). This was probably due to a considerable proportion of the material measured by gravimetric analysis having a carbon number higher than 50, the practical upper limit of the GC-FID

procedure used. Indeed it is known that some commercial grades of wax coatings for bread wrapping, are a blend of waxes and polymers. The higher molecular weight fraction that makes up the difference between gravimetric and GC-FID results could be due to blending different waxes and/or polymers together.

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A copy of the full report of this survey has been placed in the library in Aviation House, 125 Kingsway, London, WC2B 6NH

Table 1: Details of samples obtained

Sample no.	Product	Brand	Size/ Product weight	Country of origin	Batch code	Barcode	Best before date	Date of purchase	Retail outlet
1	Bio Activia (Low Fat Bio Yogurt)	Danone	500g	UK	06/12B 16:22	5 410146 401749	6/12	14/11/01	Safeway
2	Thick & Creamy Yogurt (Smooth Strawberry)	Muller	500g	UK	15:02 NP3 G3	4 025500 003401	05-Dec	14/11/01	Safeway
3	Natural Yogurt (Live Full Fat)	Longley farm	454g	UK		5 010578 003230	28-Nov	17/11/01	GT Smith
4	Strawberry Yogurt (Virtually Fat Free)	Muller Light	200g	UK	08:48 5 A3 R2 NP	4025 5309	19/11/01	15/11/01	Co-op
5	Mousse (Vanilla)	Cadbury's	100g	UK	3 4 12:12	5 000373 083506	10/12/2001	26/11/01	Cost Cutter
6	Creme Fraiche (Luxury Full Fat)	Heritage	20 cl	UK	CH14281098	5 010893 840701	30/11/2001	17/11/01	G T Smith
7	Thin & Crispy Pizza (Magherita)	Morrisons	150g	UK		0 282574 000659	04/12/2001	28/11/01	Morrisons
8	Cottage Cheese (Natural)	ASDA	454g	UK		W 2036 5639 G	23/11/01	21/11/01	ASDA
9	Tuna & Sweetcorn (Sandwiches)	CSL		UK			22/11/01	21/11/01	CSL Canteen
10	Baby Sponge (Sponge Cake)	G T Smith		UK		0 201480 000973	21/11/2001	17/11/01	G T Smith
11	Crunch Corner (Vanilla / puffed rice)	Muller	150g	UK		4025 5729	07-Dec	20/11/01	Somerfields
12	Cheese Cake (Strawberry)	Heritage	100g	UK	<K> 12:49	5 010893 720041	05/12/2001	26/11/01	Cost Cutter
13	Sweetex Tablets	Sweetex	500 tablets	UK	L17JJ	5 000167 002119	Jul-04	28/11/01	Morrisons
14	Chocolate Fingers (Biscuits covered in milk chocolate)	Cadbury's	150g	UK	L1281150	5 000183 948101	07/07/2002	21/11/01	ASDA
15	Quark, Soft cheese (Virtually Fat Free)	Orchard Dairy	250g	UK		5 022241 058539	16/12/01	28/11/01	Morrisons
16	Cream UHT (Individual Portion)	Cuisine		UK	UK JY501M EEC	050 10125 101426	02/06/2002	26/11/01	CSL Canteen
17	Dates (Specially Selected)	Morrisons	227g	UK	242 E1	0 265674 001092	May-02	28/11/01	Morrisons
18	Milk UHT (Individual Portion)	Cuisine		UK				26/11/01	CSL Canteen
19	Mixed Peel (Cut)	Nisa	100g	UK	506011	5 010893 020141	Oct-02	27/11/01	Cost Cutter
20	Soured Cream (Fresh)	Sainsbury's	142g	UK	71-140BN	0011 0690	07/12/2001	29/11/01	Sainsbury's

Table 1: Details of samples obtained (continued)

Sample no.	Product	Brand	Size/ Product weight	Country of origin	Batch code	Barcode	Best before date	Date of purchase	Retail outlet
21	Sunflower Spread (Individual Portion)	Cuisine		UK	UK AC 006 EEC	5 000246 000609	03/12/2001	26/11/01	CSL Canteen
22	Pork Mince (British)	Tesco	500g	UK	W6B 40141326	5.03102E+12	21/11/01	19/11/01	Tesco
23	Beef Mince (British)	Tesco	454g	UK	D 318 21:10	5 000436 726005	21/11/01	19/11/01	Tesco
24	Chicken Breast (Skinless Fresh Fillets)	Tesco	606g	UK	4032	5 050179 844139	21/11/01	19/11/01	Tesco
25	Chicken Mince (Class A Fresh)	Tesco	500g	UK	1317A13:12	5 031021 840172	20/11/01	19/11/01	Tesco
26	Mackerel (Headless and gutted)	Sainsbury's	500g	UK	XQ009FE IO262	0217719001598/ 0217712001557/ 0217710001610	19/11/2001	19/11/01	Sainsbury's
27	Sugar Free Safari Cups (Blackcurrant)	Calypso	185ml	UK	1249	5 010679 008257	Sep-02	15/11/01	Somerfield
28	Goujons (Chicken)	ASDA	275g	UK	5037	W 2201 1794 G	25/11/01	21/11/01	ASDA
29	Pork Pie (Basics)	Somerfield	4pk	UK	319 1 320	5 000192 187959	25-Nov	20/11/01	Somerfield
30	Coleslaw (Good Intentions)	Somerfield	250g	UK	3210	2900 0906	22-Nov	20/11/01	Somerfield
31	Medium Sliced White Bread (Bakers Premium)	Tesco	800g	UK	3 E 3 G D 7	5 031021 153630	18/11/01	14/11/01	Tesco
32	White Bread (Medium Sliced)	Warburtons	800g	UK	7AXV DPKM4	5 010044 000039	24/11/01	21/11/01	ASDA
33	Big White (Medium Sliced)	ASDA	800g	UK	1 G 19 GD8	W 2038 0144 G	24/11/01	21/11/01	ASDA
34	Scottish Plain (Medium Sliced)	Mothers Pride	800g	UK	X03.6	5 010003 004016	24/11/01	21/11/01	ASDA
35	Krisprolls (Original Cracked Wheat)	Pogen	200g	UK	46-9N4K	7 311070 330816	Jun-02	28/11/01	Morrisons
36	Premium Bread Mix (White)	Wright's	500g	UK	10:45 GMB 1283	5 020387 000290	04/10/2002	28/11/01	Morrisons
37	Soothers (Blackcurrant)	Halls	45g	UK	25601	5 010455 063142	22/10/03	14/11/01	Safeway
38	Tunes (Cherry)	Tunes	37g	UK	U5A	5015 9093	08/09/2003	15/11/01	Co-op

Table 1: Details of samples obtained (continued)

Note: Sample numbers 45, 46, 47, 49, 51, 52 and 57 - 63: samples were purchased and then found to have a type of packaging that was different from that expected (e.g. an expected 'greaseproof' wrap was in fact a plastic film) or it was found that there was no contact between the packaging and the food.

Sample no.	Product	Brand	Size/ Product weight	Country of origin	Batch code	Barcode	Best before date	Date of purchase	Retail outlet
39	Chewits (Strawberry Chewy Sweets)	Leaf		UK	6A	5 010933 011207	Oct-02	17/11/01	Day & Nite
40	Mega Drumstick (Chewy Sweet Lolly)	Matlows		UK		5 010478 510586		17/11/01	Day & Nite
41	Fishermans Friends (Extra Strong)	Lofthouse	25g	UK	26464	5081 9485	2003	26/11/01	Costcutter
42	After Eight (Plain Chocolate with Peppermint filling)	Nestle	300g	UK	L115EB 10:32	5 000426 128017	04/08/2002	26/11/01	Sainsbury's
43	Popcorn (Microwave)	Popz	300g	DK	1631202601	5 706516 030146	Dec-02	26/11/01	Sainsbury's
44	White Bread (Medium Sliced)	Morrisons	800g	UK	EB	0 281973 000420	19-Dec	28/11/01	Morrisons
48	Creamy Butter (Salted)	Co-op	250g	UK	LB1	5 000128 069885	30-Dec	15/11/01	Co-op
50	Lard	Co-op	250g	UK	285T9	5 000128 492270	Jul-02	15/11/01	Co-op
53	Baking Cases (Floral)	Deeko	100 cases	UK	1254A	5098 9201		26/11/01	Costcutter
54	Raisins (Snack Packs)	Sun Maid	14g	USA		0 41143 02550	Feb-03	25/11/01	Sainsbury's
55	Grated cheese (Italian)	Galbani	42.5g	I	CAA	5 010602100119	Apr-02	28/11/01	Morrisons
56	Ice Cream (Vanilla)	Somerfield	1Ltr	UK	RA1311/19:38 (8)	5 000192 142743	Nov-02	18/11/01	Somerfield
64	Quaker Oats (Rolled Oats)	Quaker	500g	UK	17:30. 13:41, 20:32	5 000108 022510	24/09/2002	17/11/01	G T Smith
65	Gravy (Granules)	Bisto	170g	UK	1262	18:26A	Feb-03	28/11/01	Morrisons
66	Red Wine (French)	Minervois	75cl	F	L 1 001 B2	2112 0022	21/11/02	21/11/01	ASDA
67	White Wine (Qualitatswein)	Blue Nun	750ml	G	L 1220 1	5 010429 000074	21/11/02	21/11/01	ASDA
68	Red Wine (Spain)	Valhondo	750 ml	E	10180	8 410396 780011	23/11/02	23/11/01	Corks & Cans
69	Chardonnay (Californian)	Blossom Hill	75cl	USA		5 410316 286978	23/11/02	23/11/01	Corks & Cans

Table 1: Details of samples obtained (continued)

Sample no.	Product	Brand	Size/ Product weight	Country of origin	Batch code	Barcode	Best before date	Date of purchase	Retail outlet
70	Merlot (Australian)	Oxford Landing	750 ml	Australia	L1107/1	9 311789 563466	28/11/02	28/11/01	Sainsbury's
71	Sauvignon Blanc (New Zealand)	Marlborough	750 ml	NZ	PO204.0	9 416917 520905	28/11/02	28/11/01	Sainsbury's
72	Champagne (Extra dry)	Sainsbury's	37.5cl	F	LO 313 A	176361	26/11/02	26/11/01	Sainsbury's
73	Asti (Spumanti)	Martini	75cl	I	P01303S17:12 L1208	8 000570 005056	26/11/02	26/11/01	Sainsbury's
74	White Grenache (Rose Wine. California)	Ernest & Julio Gallo	750ml	USA	243279	0 85000 00287	26/11/02	26/11/01	Sainsbury's
75	Solera 1842 (Sherry)	Valdespino	37.5 cl	Es	L- 1108/0151115 9	8 412449 101453		05/12/01	ASDA
76	Port (Tawny)	ASDA	750 ml	Port	L1291 Pas	2114 7548		05/12/01	ASDA
77	Bourbon (Frontier Whiskey)	Bulleit	70 cl	USA	45109491J	5 000299 288009		10/12/01	Tesco
78	Peach Slices (In Syrup)	Del Monte	227g	Greece	PR7GL21415 6	24000 01114	31/12/04	26/11/01	Costcutter
79	Fruit Salad (In Syrup)	Del Monte	227g	RSA	L0611N	24000 01147	30/06/04	26/11/01	Costcutter
80	Tango (Orange)	Britvic	330ml	UK	1255 03:10	5 010102 003439	Sep-02	30/11/01	Netto
81	7up (Lemon/Lime Drink)		0,33L	UK	43L126821	8717 7756	Sep-02	30/11/01	Netto
82	Irn-Bru (Sparkling Flavoured Soft Drink)	Barr	330ml	UK	21:25 1282	5010 7438	Apr-03	10/12/01	Tesco
83	Baked Beans (In Tomato Sauce)	Heinz	200g	UK	3161 23:35	5 000157 024855	Oct-02	26/11/01	Sainsbury's
84	Baked Beans (In Tomato Sauce)	Heinz	415g	UK	2991 05:14	5 000157 024671	Jan-03	26/11/01	Sainsbury's
85	Baked Beans (Reduced Salt & Sugar)	La Campagna	425g	UK	BB16 LM278 13:04	5 021490 808674	Oct-03	30/11/01	Netto
86	Spaghetti In tomato sauce (Weight Watchers)	Heinz	200g	UK	2711 05:45	5 000157 024961	Oct-02	26/11/01	Sainsbury's
87	Spaghetti hoops In tomato sauce (Weight Watchers)	Heinz	200g	UK	2830 01:54	5 000157 024954	Oct-02	26/11/01	Sainsbury's

Table 1: Details of samples obtained (continued)

Sample no.	Product	Brand	Size/ Product weight	Country of origin	Batch code	Barcode	Best before date	Date of purchase	Retail outlet
88	Party Hot-dogs (In Brine)	Plumrose	411g	UK	L22101 11:15 A 5	5 010023 025008	Oct-03	28/11/01	Morrisons
89	Soup (Vegetable)	Farmers Fayre	410g	UK	1284 16:04 08	5 021490 809275	Oct-03	30/11/01	Netto
90	Sliced Carrots (In Salted Water)	Sainsbury's	300g	UK	31P1285 11:59	0116 3605	Oct-04	26/11/01	Sainsbury's
91	Processed Peas (Marrowfat)	Sainsbury's	145g	UK	1297 09:59 04	0011 6022	Oct-05	26/11/01	Sainsbury's
92	Coke (Diet)	Coca Cola	150ml	UK	L1269SC608:4 0	5449 1076	Mar-02	28/11/01	Morrisons
93	Coke (Regular)	Coca Cola	330ml	UK	L1325WA119: 35		Nov-02	28/11/01	Morrisons
94	Smoked Tuna Slices (In Sunflower Oil)	John West	120g	Thailand	X170W	5 000171 033550	Jun-02	28/11/01	Morrisons
95	Medium Red Salmon (In Brine)	Glenryck	200g	UK	A684M 10B01 P	5 010821 999808	Apr-04	28/11/01	Morrisons
96	Mince Beef & Onion Pie (Lean Mince Beef/Puff Pastry)	Fray Bentos	425g	UK	1299 10:40	5 000175 402321	Oct-03	28/11/01	Morrisons
97	Oxtail soup (Low Fat)	Sainsbury's	95g	UK	1299AG	0108 8632	Oct-03	26/11/01	Sainsbury's
98	Hamburgers (Pork & Bacon)	Elmhirst	425g	UK	1319 724 8	5 021490 808254	Nov-04	30/11/01	Netto
99	Giant Hot Dogs (In Brine)	Ye Olde Oak	560g	UK	3631L186K64	5 010431 003810	Sep-04	04/12/01	Morrisons
100	Sponge Pudding (Treacle)	Mrs Carter	300g	UK	SS 1317	5 021490 808667	Nov-04	30/11/01	Netto
101	Rice Pudding (Creamed)	Tesco	425g	UK	1191 LTHO 10:46	5 000436 369936	Jul-03	10/12/01	Tesco
102	Corned Beef (100 per cent Corned Beef)	Streamline	340g	UK	1101110	5 011343 300035	2006	28/11/01	Morrisons
103	Tomato Puree (Double concentrate)	Tesco	142g	UK	CO2 L M257	5 000119 089731	Sep-03	10/12/01	Tesco
104	Rice (Long Grain)	Uncle Bens	375g	UK	210204C	5 410673 001009	21/02/04	25/11/01	Sainsbury's
105	Meringue Nests	Lee's	6 nests	UK	042851/C	5 010082 835020	04/04/2003	26/11/01	Costcutter
106	Panattone di Milano (Cake)	Sainsbury's	100g	I	38 2 01	8053 8141	Apr-02	26/11/01	Sainsbury's

Table 1: Details of samples obtained (continued)

Sample no.	Product	Brand	Size/ Product weight	Country of origin	Batch code	Barcode	Best before date	Date of purchase	Retail outlet
107	Poppodums (Plain)	Sharwoods	94g	I	1303	5 000197 571401	Apr-03	26/11/01	Sainsbury's
108	Lasagne (Organic)	The Enjoy Organic	250g	I	1253	5 060012 342029	Sep-03	28/11/01	Morrisons
109	Fish Fingers (100 per cent Haddock Fillet)	Birds Eye	300g	UK	L12491110123	5 000116 041015	Mar-03	28/11/01	Morrisons
110	Icing Sugar (Finest)	Whitworths	500g	UK	3431D18Z	5 013026 085864		26/11/01	Sainsbury's
111	Dried Peas (Bigga, Marrowfat)	Batchelors	250g	UK	1298WO	5011 3156	01/09/2003	26/11/01	Sainsbury's
112	Haddock Steaks (In crispy batter)	Birds Eye	198g	UK	L1229043123	5 000116 025459	Feb-03	26/11/01	Costcutter
113	Hot dogs (In Brine)	Lancaster	400g	UK	1284	5 000232 213907	Dec-04	10/12/01	Tesco
114	Wee Willie Winkies (Skinless Sausages)	Halls	205g	UK	B 3	5033 9518	15/12/2001	10/12/01	Tesco
115	Frankfurters (Beachwood Smoked)	Herta	140g	UK	AZ	3 154203 049036	28/12/2001	10/12/01	Tesco
116	Skinless Sausages (Irish Recipe)	Richmond	213g	UK	ADO	5 000187 008238	17/12/2001	10/12/01	Tesco
117	Pork Sausages (Skinless)	Walls	907g	UK	09A 20:24	5 000187 002845	Oct-02	10/12/01	Tesco
118	Pork Sausages (Skinless)	Somerfield	227g	UK	50880	2901 3685	25/12/2001	17/12/01	Somerfield
119	Sausages (Quorn)	Quorn	250g	UK		5 019503 001891	05/01/2002	18/12/01	Somerfield
120	Skinless mini pork sausages (Skinless)	Marks And Spencers	205 g	UK	1788GH002A	M 0172 080 S	01/10/2002	22/12/01	Marks and Spencers

Table 2: Results from the check sample exercise for mineral hydrocarbon analysis

In all cases the product used in the 'spike' was correctly identified by CSL in samples supplied 'blind' to them. Results are from single determinations of each sample and are corrected for analytical recovery.

	Product used in spike	'Spike' level mg/kg	Level reported (mg/kg)	Measurement accuracy (per cent)
Yoghurt				
1	N70H oil	116	118	102
2	Blank	none	ND*	NA
3	Engine oil	167	185	111
4	Blank	none	ND*	NA
5	N70H oil	189	187	99
6	Engine oil	107	92	86
Bread				
1	LMP wax	70	66	94
2	Candle wax	240	253	105
3	Candle wax	125	123	98
4	Blank	none	ND #	NA
5	LMP wax	58	56	97
6	Blank	none	ND #	NA

Notes:

* not detected; limit of detection = 2 mg/kg

not detected; limit of detection = 0.05 mg/kg

NA: not applicable

LMP: low melting point

Table 3: Levels (g/kg) and profiles of mineral oil detected in polystyrene samples

Notes: Av.C-no: average carbon number; <Cx: percentage mineral hydrocarbon with a carbon number less than C20, C25, C30 or C35; Cn: the carbon number at the 5% or the 95% level

Sample no.		Oil, g/kg	Av. C-no.	< C20 (per cent)	< C25 (per cent)	< C30 (per cent)	< C35 (per cent)	5 per cent Cn	95 per cent Cn
1	Bio Activia	24	37	<1	<1	13	66	31	41
2	Thick and Creamy Yogurt	24	36	<1	<1	13	58	30	42
3	Natural Yogurt	25	36	<1	<1	13	62	29	40
4	Strawberry Yogurt	15	35	<1	<1	18	61	30	43
5	Mousse	19	36	<1	<1	6	54	31	40
11	Crunch Corner	9	36	<1	<1	21	63	30	42
12	Cheese Cake	18	34	<1	<1	17	71	30	39
13	Sweetex Tablets	30	36	<1	<1	12	60	31	41
15	Quark, Soft Cheese	19	34	<1	<1	20	66	29	42
16	Cream UHT	20	36	<1	<1	20	65	29	42
17	Dates	47	36	<1	<1	10	57	32	41
18	Milk UHT	16	35	<1	<1	24	63	29	42
19	Mixed Peel	24	35	<1	<1	22	66	30	42
20	Soured Cream	22	36	<1	<1	15	60	30	41
21	Sunflower Spread	26	34	<1	<1	33	68	28	40
27	Sugar Free Safari Cups	22	35	<1	<1	23	68	29	42
28	Goujons	33	29	<1	32	88	100	24	35
30	Coleslaw	22	36	<1	<1	20	69	29	41

Table 4: Levels (g/kg) and profiles of wax in ‘waxed’ paper or board samples used to wrap food and sugar confectionery items

Notes: Av.C-no: average carbon number; <Cx: percentage mineral hydrocarbon with a carbon number less than C20, C25, C30 or C35; Cn: the carbon number at the 5% or the 95% level

Sample no.		Wax, g/kg (GC-FID analysis)	Wax, g/kg (Gravimetric analysis)	Av. C-no.	GC-FID distribution of LMW fraction						Based on gravimetric result		
					< C20 (per cent)	< C25 (per cent)	< C30 (per cent)	< C35 (per cent)	5 per cent Cn	95 per cent Cn	Av. C-no.	< C25 (per cent)	< C35 (per cent)
<i>Waxed paper:</i>													
31	Medium Sliced White Bread	164	314	28	<0.2	29	90	100	26	33	38	15	52
32	White Bread	150	298	29	<0.2	28	89	99	26	33	38	14	50
33	Big White	152	309	28	<0.2	29	90	100	26	33	38	14	49
34	Scottish Plain	152	295	28	<0.2	30	90	100	25	37	38	15	52
37	Soothers	87	452	31	<0.2	8	59	97	27	37	46	2	18
38	Tunes	101	362	29	<0.2	26	90	99	25	37	44	7	27
39	Chewits	3.5	128	34	<0.2	6	42	88	27	38	50	0	3
40	Mega Drumstick (a lolly)	97	227	30	<0.2	17	64	93	25	38	41	7	40
44	White Bread	272	424	29	<0.2	25	83	99	25	37	35	16	64
53	Baking Cases	6.9	143	30	<0.2	22	71	96	25	37	49	1	5
<i>Waxed board:</i>													
56	Ice Cream	7.1	255	29	<0.2	35	77	96	24	37	49	1	3
64	Quaker Oats	0.35	0.4	28	<0.2	33	100	100	26	31	29	29	88

Table 5: Levels (g/kg) and profiles of oil and wax detected in samples of corks

Notes: Av.C-no: average carbon number; <Cx: percentage mineral hydrocarbon with a carbon number less than C20, C25, C30 or C35; Cn: the carbon number at the 5% or the 95% level; ND: not detected (the limit of detection for oil in cork was 20 mg/kg and 1 mg/kg for the individual *n*-alkane hydrocarbons.)

Sample no.		Oil, g/kg	Av. C-no.	< C20 (per cent)	< C25 (per cent)	< C30 (per cent)	< C35 (per cent)	5 per cent Cn	95 per cent Cn	Wax, g/kg	Av. C-no.	< C20 (per cent)	< C25 (per cent)	< C30 (per cent)	< C35 (per cent)	5 per cent Cn	95 per cent Cn
66	Red Wine	ND								1.5	34	<0.2	12	33	80	24	40
67	White Wine	5.7	30	2	24	63	83	22	39	1.0	29	<0.2	11	88	100	26	33
68	Red Wine	2.1	36	<1	<1	23	79	30	40	13	29	<0.2	23	67	97	25	36
69	Chardonnay	ND								0.5	30	<0.2	16	91	100	24	33
70	Merlot	ND								3.3	30	<0.2	12	71	99	26	36
71	Sauvignon Blanc	ND								9.8	27	2	54	93	100	23	33
72	Champagne	ND								3.6	27	1	45	94	100	23	32
73	Asti	ND								0.6	28	<0.2	44	95	100	24	32
74	White Grenache	ND								0.2	27	<0.2	47	97	100	23	31
75	Solera 1842	ND								0.3	31	<0.2	17	65	100	25	36
76	Port	ND								4.9	27	<0.2	52	96	100	23	32
77	Bourbon	ND								4.5	27	<0.2	40	94	100	24	33

Table 6: Levels (g/kg) and profiles of oil detected in samples of skinless sausages

Notes: Av.C-no: average carbon number; <Cx: percentage mineral hydrocarbon with a carbon number less than C20, C25, C30 or C35;
Cn: the carbon number at the 5% or the 95% level

Sample no.		Oil, mg/kg	Av. C-no.	< C20 (per cent)	< C25 (per cent)	< C30 (per cent)	< C35 (per cent)	5 per cent Cn	95 per cent Cn
114	Wee Willie Winkies	2	25	21	86	98	100	21	16
115	Frankfurters	9	26	7	55	100	100	23	29
116	Skinless Sausages	18	26	12	64	100	100	23	29
118	Pork Sausages	28	27	13	53	98	100	22	30
120	Skinless mini pork sausages	21	27	14	80	100	100	22	29

Table 7: Level (g/kg) and profile of oil detected in a sample of canned food

Notes: Av.C-no: average carbon number; <Cx: percentage mineral hydrocarbon with a carbon number less than C20, C25, C30 or C35;
Cn: the carbon number at the 5% or the 95% level

Sample no.		Oil, mg/kg	Av. Cn	< C20 (per cent)	< C25 (per cent)	< C30 (per cent)	< C35 (per cent)	5 per cent Cn	95 per cent Cn
88	Party Hot-dogs	8	26	13	78	9	100	21	29

Table 8: Food samples tested for mineral hydrocarbon migration from their associated packaging

Notes: Cn: carbon number; Cn max: the carbon number at which the GC-FID profile maximises; mass per cent: the mass of the mineral hydrocarbon present with a carbon number less than C25; ND: not detected; NA: not applicable; 1: analysed in duplicate; 2: detection limit: 0.5 mg/kg, 3: for these samples for which there was no detectable migration, the fraction below C₂₅ is taken from the packaging analysis results; 4: detection limit: 0.3 mg/kg; 5: detection limit: 2 mg/kg.

Sample no.		Wax (mg/kg)	Cn. range	Cn. max abundance	5 per cent Cn	mass per cent at <C25	migration of <C25, mg/kg
Waxed Paper							
31	Med. Sliced White Bread	13	21-34	28	25	15	2.0
32	Medium Sliced White Bread	9.9	21-34	28	25	12	1.2
33	Big White	6.3	19-34	29	25	4.9	0.3
34	Scottish Plain	7.2, 7.1 ¹	19-33	28	24	19, 20	1.4
44	White Bread	31	19-34	29	25	10	3.3
37	Soothers	3.6	23-34	30	27	7.8	0.3
38	Tunes	2.3	22-34	28	25	13	0.3
39	Chewits	0.6	23-30	29	27	<10	<0.06
40	Mega Drumstick	11	23-34	31	25	10	1.1
Waxed Board							
56	Ice Cream	ND ²	NA	NA	NA	(35per cent) ³	ND, <0.2
64	Quaker Oats	ND ⁴	NA	NA	NA	(33per cent) ³	ND, <0.1
Polystyrene		Oil (mg/kg)					
28	Goujons (Chicken)	ND ⁵	NA	NA	NA	(32per cent) ³	ND, <0.6

Table 9: Distribution of wax in cakes cooked in paper cases

Notes: Cn: carbon number; Cn max: the carbon number at which the GC-FID profile maximises; mass per cent: the mass of the mineral hydrocarbon present with a carbon number less than C25;
Baking cases from sample no. 53 (Table 4) were used.

	Wax (mg/kg)	Cn range	Cn max abundance	Cn at 5 per cent	mass per cent at <C25	Migration of <C25, mg/kg
Cake core	4.9	23-35	27	22	25	1.2
Cake surface	45	20-35	27	24	9.1	4.1
Whole cake	29	20-35	27	23	11	2.9