FOOD STANDARDS AGENCY

WORKING PARTY ON MATERIALS AND ARTICLES IN CONTACT WITH FOOD OR DRINK

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INTRODUCTION

Research commissioned by the Food Standards Agency into chemical migration from food contact materials and articles, provides information and practical methods to help the Agency to meet its consumer safety objectives. The Working Party on Materials and Articles in Contact with Food or Drink gives independent advice on this research. The aim of the programme is to help build a sound scientific basis for UK input to international negotiations in the European Union. The experimental work includes: the development of test methods for chemical migration; the investigation of factors that may influence chemical migration; and the study of materials used in food contact applications with a view to identifying possible migrants from starting substances or reaction and breakdown products. An extensive range of materials is researched. For example projects reviewed at the meeting reported here include work on latex protein transfer, ion-exchange resins, silicones, and colourants used in plastics. Projects are awarded to contractors after open competition and are carefully managed to ensure value for money in both the science that they produce and their relevance to the work of the Food Standards Agency.

To ensure that work in this research programme relates to current industrial practice, the membership of the Working Party on Materials and Articles in Contact with Food or Drink includes experts from industry as well as consumer and regulatory interests. The activities of the Working Party are structured around two meetings a year, in the Spring and Autumn. The Spring meeting reviews research projects in progress, whilst the one in the Autumn considers future research.

This review document provides a full record of the Spring 2004 meeting. It has been produced as part of the Agency's policy of openness, to disseminate information about this research programme to stakeholders.

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ASSESSMENT AND QUANTIFICATION OF LATEX PROTEIN (LP) TRANSFER FROM LP-CONTAINING MATERIALS INTO FOOD AND DRINK (PROJECT A03043)

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BACKGROUND AND OBJECTIVES

According to WHO-IUIS, latex allergens (LA) comprise 16 different latex proteins (LP) that are present in natural rubber. Of these, the major clinically relevant allergens with maintained allergenicity in the final manufactured natural rubber latex (NRL) products are thought to be Hev b 1, Hev b 3, Hev b 5 and Hev b 6.02. The clinical symptoms of allergic reactions include contact urticaria and anaphylactic shock.

LP-containing materials (e.g. gloves and packaging) are used in contact with food. The overall aims of this project are to determine the extent of usage of LP-containing materials in the food chain, and to examine the possibility of transfer of low levels of LA from LP-containing materials in contact with food and drink products.

The main deliverables are as follows:

- A detailed report on LP-containing materials used as contact materials in the food chain.
- A report showing data on the potential transfer of low levels of major LAs in food and drink products using quantitative enzyme-linked immunosorbent assays (ELISAs).

The overall approaches include:

- A detailed consultative exercise with selected food, drink and latex product manufacturers and retailers, and reference to the literature, to determine the extent to which materials containing LP are used as food contact materials.
- The development of reliable protocols in combination with FITkits™ ELISAs for the quantification of possible transfer of low levels of LAs into food and drink products.

PROGRESS

Natural rubber latex (NRL) can be found in over 40,000 products. These are used in a wide range of environments including medicine and the home.

Symptoms of latex allergy can range from localised skin rash to anaphylactic shock and even fatalities. Reports of latex allergy are on the increase. Reports of the incidence of latex sensitisation and allergy vary widely. A report in 1995, estimated that about 1% of the general population is sensitised to latex but only a small proportion of these people have latex allergy.

A questionnaire was designed, to determine possible usage of latex containing products within the food industry. The questionnaire was sent to food manufacturers, food ingredient companies and catering companies. In summary:

- 80% of the respondents were aware of latex allergy.
- No respondents added latex as an ingredient in any of the food products they manufactured.
- Latex gloves were the most likely possible source of latex, used in the food manufacturing/food handling process (47%).
- Rubber bands were the next most commonly used possible source of latex, in the food manufacturing/food handling process (24%).
- Several manufacturers were unaware if the products they used contained latex or not.
- 7% of respondents had received consumer complaints/queries relating to latex allergy.
- 13% of respondents were aware of past or current staff having a latex allergy.

Several companies were 'phoned to determine if they used or manufactured products containing latex. The results of the telephone interviews are summarised below:

- The food manufacturers and the conveyor belt manufacturers did not use latex in any part of their manufacturing process.
- Manufacturers of adhesives, protective gloves, food processing equipment and food packaging stated that latex was used in each of the products they produced.
- Adhesive manufacturers used latex as a component in cold seal adhesives for chocolate bar and ice cream wrappers, which had the potential to come in contact with foods.
- Latex was used as a component of several types of protective gloves. Latex could therefore come into contact with food if latex-containing gloves were worn by food handlers.
- Latex was generally not used in any food processing equipment, but could be used in bakery release films. These films help shaped foods (i.e. pie tops) to be stamped out of a sheet of pastry without sticking.
- Food packaging manufacturers stated that latex was not generally used in any food packaging, but could be used in the manufacture of rubber bands.

FITkit ELISAs (FIT Biotech) were successfully set-up for the quantification of LAs and their performance established. The dynamic assay ranges were 2.7-1,000 ng/ml (for Hev b1), 2.8-1,000 ng/ml (Hev b3), 2.1-100 ng/ml (Hev b5) and 2.3-200 ng/ml (Heb b6). Based on the calibration curve, the assay performance in general was as follows: (i) lower limit of detection (2.1 to 2.8 ng/ml); and (ii) precision (repeatability <10% CV, reproducibility <15% CV). The assays were highly specific as no cross-reaction was found when each assay for a LA was challenged with the other LA's at 1,000 ng/ml.

The ELISAs were successfully used to assess the level of latex allergens in a range of gloves (latex, vinyl and nitrile). For Hev b5 and b6 allergens, latex gloves were measured as containing 82.9 ng/ml and 90.5 ng/ml LA, respectively. No response was observed with the vinyl and nitrile gloves, indicating that no LA was present. Literature data indicates a high degree of variability between different brands of latex gloves (e.g. 41-1,803 ng/ml for Hev b5 in powder-free latex gloves).

In a commercial cold seal adhesive, LA were measured at 0.97 µg/ml (Hev b1), 0.84 µg/ml (Hev b3), 2.8 µg/ml (Hev b5) and 36 µg/ml (Hev b6).

Measurement of latex allergens from spiked foods

Four commercial confectionery products (e.g. digestive biscuit, wafer and chocolate bar), were used in this study. In a typical experiment, Hev b1, b3, b5 and b6 were ‘spiked’ at 10-200 ng/ml levels into a crude food homogenate, followed by extraction and measurement by the ELISAs. The overall recovery varied from 75-97%.

Although potential cross-reactivity is possible, this is expected to be limited to only certain food and drink products (e.g. those containing avocado, kiwi and banana). In our studies, no cross-reactivity was observed with kiwi, banana, tomato or orange juice when the ELISAs were challenged with the fruit, extracted 1:10 in PBS. With avocado, whilst no cross-reaction was observed for Hev b1, b3 and b6, there was a slight cross reaction (corresponding to approximately 5 ng/ml Hev b5) in the Hev b5 assay.

FUTURE WORK

Work will continue, with the following objectives:

- To develop more sensitive assays (approximate dynamic range: 1 – 10 ng/ml) for LAs, by modifying the existing commercial ELISAs, prior to determining possible transfer of low levels of LAs in foods in contact with LP-containing materials.

- To investigate the effects of treatment (e.g. heat denaturation) on the extent of cross-reaction between fruit and latex allergens.

- To draft and clear the project report.

SUBSTANCES MIGRATING FROM ION EXCHANGE RESINS

(PROJECT A03042)

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BACKGROUND

Ion exchange resins are used in food processing for water softening and food product purification. They are not yet specifically included in Council Directive 89/109/EEC, relating to materials and articles intended to come into contact with foodstuffs. In most cases, relatively large surface areas of ion exchange resin make contact with the foodstuff. It is possible that these macro-molecular compounds could release chemical species involved in their production together with reaction intermediates and decomposition products, during contact with food.

The Council of Europe has issued a resolution on ion exchange and adsorbent resins used in the processing of foodstuffs (Resolution AP (97) 1). This provides specifications for such materials and an inventory list (currently under revision). Specifications include a restriction on total organic carbon in the fifth bed-volume extracted from the resin of 1mg/litre and any specific migration limit restrictions also to be examined on this extract.

The US FDA details requirements on ion exchange resins in Chapter 21, Section 173.25 of their regulations. This includes restrictions on organic extractives and nitrogen extractives under specified resin washing and treatment protocols.

Issues to be addressed at the outset of this 12 month project were:

a) Are the current EU Food Simulants applicable?
b) Is there a requirement to examine chemical migrants in more concentrated acid or alkali?
c) Does regeneration introduce resin breakdown and potential migratory species?
d) Should misuse be investigated?
e) Is testing the fifth bed volume of resins an adequate restriction to prevent hazardous migration in practice?
f) Can any migrants from ion exchange resins be detected in food?

PROGRESS

To help answer these questions, a review has been completed on the types, applications, usage conditions and modes of action of ion exchange resins used in contact with food, with particular reference to the UK marketplace.

Specific contacts/visits have been made with users of ion exchange resins within the food industry:

a) A producer of sugar from beet.
b) A producer of sugar from cane.
c) A producer of soft drinks.
d) A producer of fruit desserts.
e) A whisky distiller.
f) A manufacturer of ion exchange resins used in the separation and isolation of proteins and enzymes from milk products.

Some of the above have provided samples for analytical investigation.

Working with a leading UK supplier of ion exchange resins, six different food-contact resins have been subjected to detailed theoretical and analytical investigation of potential migratory constituents. Issues associated with regeneration and also ageing have also been considered. The six resins are:

Resin A: A strong acid cation, gel type resin with aromatic sulphonate functionality - used for water softening.
Resin B: A strong acid cation, macroporous type resin with aromatic sulphonate functionality - used in the decalcification of sugar syrups, during isolation of sugar from beet.
Resin C: A weak acid cation, macroporous polyacrylic resin with carboxylic acid functionality - used in domestic water filters.
Resin D: A weak base anion, macroporous resin with aromatic tertiary amine functionality - used as part of the dimineralisation/decolourisation of glucose and other organic solutions.
Resin E: A strong base macroporous, anion resin with aromatic quaternary ammonium functionality - used for nitrate removal.
Resin F: A highly and rigidly cross-linked polystyrene absorbent resin of high surface area, with some tertiary amino functionality (active carbon replacement) - used for the efficient sorption of medium to high molecular weight colour species such as those found in sugar solutions.

The analytical approach to investigate potential migrants has included the following:

- Development of liquid chromatography/mass spectrometry (LC-MS) protocols for detection of ionic and polar species using an ion-trap mass spectrometer.
- Examination of volatiles from samples using dynamic headspace gas chromatography/mass spectrometry (GC-MS).
- Examination of extractables into methanol, acetone and distilled water by LC-MS.
- Examination of migration into 10 per cent ethanol (24 hours at $40^{o}C$), and then four successive bed volume rinses with 10 per cent ethanol ($40^{o}C$) using LC-MS^{n} and TOFGC-MS.

Migration studies into 10 per cent ethanol detected and identified a range of species. These included non cross-linked material containing the functional groups of the resins, non-functionalised resin fragments and some oxidation products. Larger amounts of species were found in the aromatic resins, particularly the gel resin. In general, with the aromatic resins, migratory species are at low ppm levels in the first extraction with this simulant and drop to ppb levels in the fifth bed volume wash.

Lifetimes of resin beds used in food production are typically ‘years’, although they are high throughput materials.

CURRENT WORK

This involves examining food products for the presence of any residual resin components.

CHEMICAL MIGRATION FROM ADHESIVES USED IN FOOD CONTACT MATERIALS AND ARTICLES (PROJECT A03044)

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BACKGROUND

Adhesives are used in several food contact applications to bond a wide range of materials. They may be water/solvent based, hot-melt, coldseal, heatseal, pressure sensitive or chemically reactive systems. Solidification may occur by drying, hot-melt and curing. An adhesive is not simply composed of the substances required to provide the adhesive properties, but also of substances added to provide other specific characteristics. Different types of these additives may be used, including: carriers (water or organic solvents), plasticisers, tackifiers, thickeners and fillers, surfactants, biocides, catalysts, pH adjusters, emulsifiers, waxes and antioxidants. Thus a large number and variety of chemical substances may be present in adhesives used for food contact materials. As the scope of use of these and the variety of formulations increase then the number of substances with the potential to migrate into foods may also increase. Adhesives are not yet specifically regulated at EU level.

PROGRESS

The following work has been carried out to date:

A report has been prepared summarising the current use of adhesives and the classes of adhesive formulations used in food contact applications. This has been carried out using scientific literature and other technical sources, including the Internet. Rather than duplicate previous work on adhesives, a list of samples for investigation has been agreed with the Food Standards Agency. It was agreed that the following applications are investigated, as nothing was found in the literature on them:

- sticky labels attached to thin layers of film, e.g. cling film; &
- the potential for migration from adhesive systems for sealable lidding applications and adhesives used to seal sachets/pouches for food & the seams of paper cups.

Retail samples of these have been purchased and analysed by headspace gas chromatography-mass spectrometry (GC-MS), and solvent extraction, followed by GC-MS. This should help establish the project's methodology. Examples of the adhesive used and the converted packaging will then be requested from the packaging converter/supermarket/brand owner for analytical screening.

Cartonboard may be used to produce boxes intended for direct food contact applications such as cereals, pasta or rice. Such boxes may be assembled using a water-based dispersion adhesive (ethyl vinyl acetate or polyvinyl acetate). The removal of the water, which is drawn into the cartonboard, is essential for the curing process. Deep frozen fish and vegetables may also be packed in cardboard boxes which are coated with polyethylene. Cartonboard with a polyethylene (PE) coating on both sides cannot be sealed using a water-based dispersion adhesive as the PE layer prevents the water soaking into the cartonboard and instead a hot-melt adhesive is used. Hot-melt adhesives are usually used for all box sealing applications due to the quicker curing rate of these adhesive systems. A number of unknown potential migrants have been detected (by GC-FID) in hot-melt adhesives, when these were removed from cartonboard food contact materials and extracted with hexane. The identity of these potential migrants is currently under investigation and their migration potential will be determined.

FUTURE WORK

Analytical screening of adhesive formulations and packaging materials will help to establish their composition; any potential migrants will be determined. The worst case migration potential of these substances will be calculated. Where migration could exceed specific migration limits (as applied to plastics) migration into food simulants and foods under the worst foreseeable conditions of use will be carried out, with targeted analysis of chemical migrants.

The findings of the work proposed should provide information on the uses and composition of food contact adhesives. It should also determine the potential for migration and if applicable the actual migration of these substances into food simulants and foods.

TO IDENTIFY CHEMICALS THAT COULD MIGRATE INTO FOODSTUFFS FROM PIGMENTS AND DYES, AND MEASURE THE MIGRATION OF THESE CHEMICALS INTO FOOD SIMULANTS. (PROJECT A03045)

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BACKGROUND

A Council of Europe resolution and a British Plastics Federation code of practice have been issued in which colourants are controlled by their purity and the degree that colourant is transferred in a standard test procedure. This project should provide information on substances that migrate from colourants. A wide range of colourants will be investigated. The information gained should help to inform decisions on how best to control these substances. This study started in April 2003 and will continue until Spring 2005.

Industry is supporting this project with advice from major masterbatch producers and the British Colour Manufactures Association (BCMA). The colourants most commonly used in plastics for food contact application have been identified. Different products have been considered. Selection is under review as data are obtained. Chemical additives are blended into some of the colourants to obtain a desired effect. Initial work was on identifying impurities and additives in colourants. This was done by reference to the manufacturers and by chemical analysis.

Work on the migration of colourants, additives and impurities into food simulants from plastic samples obtained from industry is in the planning stages and will start on these in the near future. Once migration has been determined this will be compared with outputs of mathematical models.

PROGRESS

Meetings with industry have established the most important pigments and dye stuffs intended for food contact applications. These have been selected for investigation in this project.

Many impurities and surface treatment chemicals in the colourants have been identified by chemical analysis. Industry has been approached for more data on these products.

The colourants were subjected to solvent extraction followed by gas chromatography-mass spectrometry and high temperature gas chromatographic (GC) analysis. Where no compounds were detected by GC analysis the extracts have been analysed by high-performance liquid chromatography using a photo diode array detector and recording the spectrum from 210 to 800nm. In a number of cases compounds have been detected in the extract and identified by mass spectroscopy using computerbased reference libraries. Where compounds were found during the solvent extraction procedure the colourants were selected for further investigation.

Test samples of plastics containing the colourants at levels typical of use were prepared for specific migration testing. The test samples are flat injection-moulded plaques, approximately 50 × 70 mm and 2 to 3 mm thick. The plastics used for sample preparation include HDPE, LDPE, PP and PET.

FUTURE WORK

The following work will be covered during the remainder of the project:

- Consideration will be given to the most appropriate test conditions, and migration will be determined into the food simulants or accepted substitutes. Using selected samples, the effect on migration of surface scouring of the plastic will also be investigated. A realistic and reproducible scouring procedure will need to be developed. It is proposed to use two samples for the scouring test, one where no migration was observed and the other where migration was analytically significant.

- Where migration is detected the concentration of the migratable species will be determined in the plastics sample. Wherever possible this will be achieved by reference to the initial concentration compounded into the polymer. In cases where this is not appropriate the polymer will be analysed to give the concentration of the migratable substance. If substances that are blended into the polymer are not found to migrate the concentrations of these species will not be determined as these are required for use in mathematical modelling only.

- Using the Fabes Migratest Lite program, predicted migration will be determined and compared to the measured value. The model used in this program is based upon Fickian diffusion principles. Input parameters required include initial concentration of migrating species in the polymer, polymer type, temperature of migration, time of migration, molecular weights of migrating species, surface area of plastic sample and volume of simulant. Predicted migration should always be greater than the observed value. If the model is found to give satisfactory predictions it can be used for further studies.

- A final project report will be submitted to the Food Standards Agency itemising the compounds found and their migration into food simulants. The ability of the above and other models to predict migration will also be discussed.

CHEMICAL MIGRATION FROM SILICONES USED IN CONNECTION WITH FOOD CONTACT MATERIALS AND ARTICLES (PROJECT A03046)

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BACKGROUND

Rapra Technology Ltd. is carrying out a research project to provide detailed information on the types and composition of silicone-based products used in contact with food. The project will identify the extent to which migration of specific constituents into food could occur.

This study started in April 2003 and was initially scheduled to continue until Spring 2004. However, it has taken longer than anticipated to obtain examples of commercial silicone products and so this has led to the project, with the agreement of the Food Standards Agency, being extended until Summer 2004.

Silicones are not regulated for food contact at the EU level in spite of the fact that they are used extensively in food contact situations. Currently there are two important documents that cover the use of silicones. The first of these is the Council of Europe resolution on Silicones (Resolution AP (99) 3) which states that they should be manufactured according to a certified Quality Assurance System (eg ISO 9002), and provides an inventory list with some specific migration limits. An overall migration limit of 10 mg/dm^2 is also stipulated. The other document is the German Recommendation XV from the BfR, which gives compositional requirements and restrictions for silicone oils, resins and rubbers.

As a guide, some examples of the silicone products used in the food industry are given below:

Silicone liquids	Additives, release agents, textile impregnation agents
Silicone pastes	Lubricants for machinery
Silicone rubbers	Sweet moulds, gaskets, seals, hosing
Silicone resins	Heat resistant coatings for bakeware, release coatings

The principal objective of this project is to establish the nature and levels of migrants from all types of silicone products to aid review of possible EU controls.

PROGRESS

Initially, a review was undertaken of literature on the types of silicone products used in the food industry, and migration data. This has been carried out by searching the

Rapra Abstracts database (the largest database dedicated to polymers in existence), consulting material in the Rapra polymer library, addressing other in-house information, and using other technical sources such as the Internet and specialist books. This review enabled predictions to be made of potential migrants from the available manufacturing, compositional and curing data.

In order to carry out compositional fingerprinting and migration work, the following representative, commercial silicone products have been obtained from a major manufacturer:

1) Three conventional silicone rubber materials – two platinum-cured materials and one peroxide.
2) One liquid silicone rubber material.
3) One water-based, high temperature curing, silicone resin product.
4) One solvent-based, high temperature curing, silicone resin product.
5) One room temperature curing, low solvent content, silicone resin product.
6) Three silicone fluids of different viscosities.

Compositional fingerprinting and migration work is being carried out on these products. The following are examples of what has been carried out so far:

a) Extracts have been prepared from cured rubbers and resins using a range of aqueous and fatty food simulants. These have been analysed by gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry to establish the range of siloxane oligomers present and to identify any breakdown products of the cure systems.

b) All the products have been analysed by dynamic headspace GC-MS to obtain a fingerprint of the volatile and, hence, potentially migratable species.

c) In the case of the silicone fluids, quantitative solvent extraction work has been carried out using a range of aqueous and fatty food simulants using a separating funnel. The dried extracts obtained in this way have then been analysed by gel permeation chromatography to characterise the molecular weight distribution of the migratable fraction.

d) Elemental fingerprinting of the products has been undertaken by inductively coupled plasma spectroscopy. Specific, quantitative elemental analysis work, e.g. for platinum in the case of the rubber samples, has been carried out.

e) There has also been work on oxidative, thermal breakdown products (e.g. formaldehyde) from rubbers and resins that have been subjected to heating during manufacture.

FUTURE WORK

Once the list of potential migrants has been finalised from the fingerprinting work, further migration testing will be undertaken. This will use aqueous and fatty food simulants and validated protocols for all of the silicone products, to determine the types and levels of migrants.

Finally, a report will be supplied to the Food Standards Agency on the chemical composition and reaction products of silicone food contact products, together with information on the identity and quantity of the species that migrate from such materials into food simulants.

LC-MS METHOD DEVELOPMENT FOR THE SCREENING OF NON-VOLATILE AND POLAR COMPOUNDS PRESENT IN PAPER AND BOARD AND PLASTIC FOOD CONTACT MATERIALS (PROJECT A03037)

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BACKGROUND

Substances in packaging materials can originate from a number of sources including: known ingredients or starting substances; impurities and transformation products of known ingredients; chemicals in inks and adhesives used to make the finished packaging; and unknown contaminants, especially those in the feedstock if paper or plastics are recycled. These substances may be important for consumer safety and improved methods for their analysis are needed.

Identification and measurement of non-volatile and polar unknown compounds is a relative weakness in the analytical chemist's armoury. Advances in LC-MS techniques have led to a rapid increase in their use for non-volatile and polar compounds. But the transfer of established LC methods to LC-MS is not always straightforward in terms of mobile phase compatibility. The consequence is that, to date, LC-MS has provided relatively little information on the polar and non-volatile substances that may migrate from paper and plastics. This project is developing LC-MS methods for the identification of polar and non-volatile substances that are present in paper and plastics and that may migrate into foodstuffs.

PROGRESS

The following work has been carried out to date:

Selection of target substances

Target substances expected to be present in paper and board were chosen in consultation with the Food Standards Agency. For substances in plastics materials and articles, these comprised nine chemical additives, five additive decomposition products, twelve monomers, six monomer decomposition products, and two oligomeric series. For substances present in paper, the target substances comprised ten additives, four additive decomposition products and two series of resin oligomers.

Literature search for available LC methods

Liquid chromatographic methods of analysis were identified from literature searches. Basic methods were found for most of the list of plastics' substances and for some of the paper chemicals. Most of the literature methods used ultra-violet, fluorescence or refractive index detectors.

Transfer of existing LC methods to liquid chromatography-atmospheric pressure chemical ionisation-mass spectrometry (LC-APcI-MS)

The aim was now to modify the selected methods for transfer to MS analysis. For each substance, the systematic approach adopted was as follows:

- Identification and selection of ions (parent and fragments) and optimisation of parameters from scanning loop fill injections of concentrated standard solutions.
- Development and application, using standard solutions in solvent, of LC conditions.

For a limited number of compounds this development work was taken further with the investigation of calibration coefficients, limits of detection, validation of methods and application to real samples. This work continues.

Semicarbazide (SEM)

In July 2003 the possible occurrence of SEM in bottled foods was reported. This was thought to be as a result of migration of this substance, and/or a parent compound (the blowing agent azodicarbonamide) from plastic gaskets used in 'push-on twist-off' lids of some jars. This part of project A03037 was conducted and reported rapidly as a contribution to continuing scientific work on the finding of semicarbazide. An independent method of test was developed for free semicarbazide and this method was validated by a between-laboratory check with TNO in the Netherlands. The presence of SEM in the blowing agent azodicarbonamide and in two of its known breakdown products, biurea and urazole, was confirmed [1]. Work in a separate project confirmed that semicarbazide can be formed from the use of azodicarbonamide and migrate from gaskets prepared using this blowing agent [2].

FUTURE WORK

The following work will be completed on substances other than semicarbazide, now that work on SEM has been completed and reported:

- Establish limits of detection (LoD) and quantification (LoQ) and spectral repeatability.
- Prepare total migrate and determine gravimetrically.
- Analyse by LC-APcI-MS and/or liquid chromatography-electrospray ionisation-mass spectrometry (LC-ESI-MS).
- Estimate concentrations.
- Calculate material balance.
- Establish atmospheric pressure ionisation (API) libraries.
- Draft and clear final report.

REFERENCES

[1] Project A03037: LC-MS Method development for the screening of non-volatile and polar compounds present in paper and board or plastic food contact materials and articles: testing for semicarbazide without derivatisation or acid hydrolysis: Final Report. W. A. Read, L. Castle, L. Coulier, E. K. Zondervan-van Beuken and M. A. H.

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BACKGROUND

Rapra Technology Ltd., with support from TNO, is carrying out a project to produce a comprehensive list of the breakdown products from rubber curatives and antidegradants that could migrate into food simulants. This study started in April 2002 and will continue until Autumn 2004. Mr Rijk and Dr Zondervan-van den Beuken of the Nutrition Department of TNO in The Netherlands will be assisting Rapra in certain areas of this project during its second and final years.

The background to this project is that a large range of rubber compounds are used in food contact situations and this has led to the development by the Council of Europe of a positive list of substances added to these materials. However, this list does not take into account the fact that two of the major classes, curatives and antidegradants, will undergo reactions during the processing and service life of the rubber products. Therefore, it will not just be the original compounds that have the potential to migrate into food, but also the breakdown products of these reactions. In the case of the curatives, the majority of the original compound will be used up in the vulcanisation reaction. The fate of the antidegradants will depend on the service conditions, but it is not unreasonable to assume that at least 50 per cent of the original compound will be converted into breakdown products during the lifetime of a specific rubber article.

The principal objective of this project will be to provide the Food Standards Agency with a complete list of the breakdown products of the 104 curatives and 68 antidegradants on the COE list.

PROGRESS

The following work has been carried out to date:
Initially a review of all the available literature on breakdown products has been undertaken. This has been carried out by searching the Rapra Abstracts database, consulting material in the Rapra polymer library, addressing in-house information, and using other technical sources such as the Internet and specialist books.

In the case of curatives it is common practice to blend accelerators in order to achieve optimum cure and product characteristics. The composition of the blend will affect the range and type of breakdown products, since the accelerators will interact with one another. For this reason, and to reduce the number of permutations, it was necessary to undertake a search of the blends that were used commercially to produce food contact rubbers. This was carried out by using the information sources described above, but with additional input from contacts in the rubber industry.

For those Council of Europe-listed compounds for which no breakdown product information could be found, Rapra's expertise and experience was used to predict the breakdown products of both individual curatives and antidegradants, and where these species were used in commercial blends.

As a result of the work carried out during the first year of the project a full, draft list of the reported breakdown products, together with the predicted products, has been submitted to the Food Standards Agency. This list also indicates the toxicity and relative abundance of the substances and hence indicates those which may be of potential regulatory interest.

During the second year of the project, 19 standard rubber compounds have been produced. These cover the range of rubber types and cure/antidegradant systems used in food applications and have been produced to address areas where little or no breakdown product knowledge exists, and to be used in food migration experiments. In every case the complete compound has been designed to ensure that it is representative of those used with food. It was important that the other chemical additives present in rubber materials (e.g. process aids) were present to ensure that authentic breakdown products were obtained. Typical levels of additives were used along with standard production conditions.

Sixteen cured sheets of each of the 19 compounds have been produced and a number of these aged using accepted standard ageing conditions for each rubber type - in order to generate breakdown products from the antidegradants (the breakdown products of the curatives having already been formed during vulcanisation).

Analysis of the 'unaged' and aged versions of the standard compounds has taken place using dynamic headspace gas chromatography-mass spectrometry (GC-MS), solvent extraction GC-MS and liquid chromatography-mass spectrometry (LC-MS) to identify the breakdown products present. The data obtained will be used to check the predictions made earlier in the project and a revised list produced if necessary.

GC-MS and LC-MS methods are being developed by Rapra and TNO to confirm if the breakdown products identified in the standard rubber compounds migrate into food simulants and, if so, at what level.

A report has also been provided to the Food Standards Agency proposing criteria and a framework for use in incorporating the breakdown products into a final inventory list.

FUTURE WORK

This is planned as follows:

- Analytical work to determine the breakdown products in the 19 standard rubbers will be completed and the information obtained will be used to revise, if necessary, the predictions made earlier in the project.

- Rapra and TNO will carry out migration work on the standard rubber compounds using aqueous and fatty food simulants to determine the extent of migration of the breakdown products.

- Draft and clear the final report with the Food Standards Agency.

ANNEX 1: AGENDA OF THE WORKING PARTY MEETING

MEETING HELD ON 18 MAY 2004 AT 11:00 AM, IN CONFERENCE ROOMS 3&4, AVIATION HOUSE, 125 KINGSWAY, LONDON, WC2B 6NH

1. Chairman’s introduction.

2. Apologies for absence.

3. Minutes of 40th meeting. (WPFCM/MIN/40/FINAL).

4. Matters arising from minutes of the 40th meeting.

5. Any other business & date of next meeting.

6. *11:30 pm:* Assessment and quantification of latex protein (LP) transfer from LP-containing materials into food and drink (WPFCM/155).

7. *11.55 am:* Substances migrating from ion-exchange resins (WPFCM/156).

8. *12.20 am:* Chemical migration from adhesives used in food contact materials and articles (WPFCM/157).

Lunch

9. *1.45 pm*: To identify chemicals that could migrate into foodstuffs from pigments and dyes, and measure migration of these chemicals into food simulants (WPFCM/158).

10. *2.10 pm:* Chemical migration from silicones used in connection with food contact materials and articles (WPFCM/159).

11. *2.35 pm:* LC-MS method development for the screening of non-volatile and polar compounds present in paper and board and plastic food contact materials (WPFCM/160).

12. Paper for information

An investigation of the breakdown products of curatives and antidegradants used to produce food contact elastomers (WPFCM/161).

SECRETARIAT

April 2004

ANNEX 2: MINUTES OF THE WORKING PARTY MEETING

Minutes of the 41st meeting held on Tuesday 18 May 2004, at 11:00 am in Conference Rooms 3&4, Aviation House, 125 Kingsway, London WC2B 6NH.

Members present

Dr D Watson (Chairman)	Food Standards Agency (FSA), Chemical Safety and Toxicology Division (CST)
Mr R Ashby	Consultant
Mr B Cass	Linpac Plastics
Dr L Castle	DEFRA Central Science Laboratory
Dr N Gault	Department of Agriculture for Northern Ireland
Mr P Grayhurst	British Glass
Mr E B Reynolds	LACORS
Mrs A Townshend	National Federation of Consumer Groups
Mr A Wakelin	British Retail Consortium
Mr R Whitaker	Crown Corporate Technologies
Dr S Sivapathasundaram	FSA, CST
Dr K Barnes (Secretariat)	FSA, CST
Mr R Sinclair (Secretariat)	FSA, CST
Mr E Potter (Secretariat)	FSA, CST

Non-members present

Dr E Bradley	DEFRA Central Science Laboratory
Dr M Forrest	Rapra Technology Ltd.
Mr J Haines	Leatherhead Food International Ltd. (LFI)
Mr A O'Brien	Pira International
Dr P Patel	LFI
Dr L Perharic	Institute of Public Health, Slovenia
Mr J Sidwell	Rapra Technology Ltd.

1. Chairman's introduction

1.1 The *Chairman* welcomed members to the 41st meeting of the Working Party. He informed members that *Richard Armstrong* had replaced *Kevin Rees* as the PIFA (Packaging and Industrial Films Association) representative on the Working Party. *Mr Armstrong* was unfortunately not able to be present on this occasion. Thanks were recorded for *Mr Rees'* contribution to the Working Party. Best wishes for the future were conveyed to him on behalf of the members and Secretariat. The *Chairman* welcomed *Dr Perharic,* a visitor from the Institute of Public Health, Slovenia.

1.2 The *Chairman* also welcomed *Dr Susila Sivapathasundaram* from the Agency who is replacing *Mrs Karen Moizer*, currently on maternity leave.

1.3 The *Chairman* reminded members that the papers and agreed minutes from this meeting are not confidential and would be included in the Review document to be published and placed on the Agency's website in due course.

2. Apologies for absence

2.1 Apologies for absence had been received from *Mr Nigel Barnwell, Mr George Hayward, Mr John Horwood* and *Mr Roger Parry.*

3. Minutes of the previous meeting (WPFCM/MIN/40)

3.1 The minutes of the 40th meeting were agreed by members and signed by the *Chairman* as a true record of the meeting.

4. Matters arising from minutes of the previous meeting

4.1 The *Chairman* informed members that the proposals for new R & D projects which the Secretariat were asked to take forward for possible inclusion in the Food Standards Agency R & D Requirements Document, would be considered for publication in the Autumn 2004 edition of this Document.

5. Any other business

5.1 The *Chairman* informed members that five projects will start in financial year 2004/05. This new work will include an investigation into the stability of BADGE in fish oils and a project to assess substances migrating from decorative shrink-sleeves. Research will also be carried out to provide information on functional barriers used in packaging and the packaged food intake of children. Another new project will develop a method for the analysis of nonylphenol in different types of packaging.

5.2 The *Chairman* informed members that, following the recent reporting of a research project on domestic use, reuse and misuse of packaging in contact with food (A03041), an article to inform consumers of the appropriate use of these materials is intended to be published in the *Food Standards Agency News*. A summary of this work can be found on the Agency's website www.food.gov.uk/. He added that following a presentation at the Agency, the Consumer's Association have published an article in *Which* magazine, outlining the findings and recommendations of the research.

5.3 *Mr Sinclair* provided members with an overview of proposed changes in EU harmonised legislation concerning food contact materials. He briefed Working Party members on the status of the European Commission's proposal for a new Framework Regulation and the 4 recently adopted Directives on azodicarbonamide, epoxy derivatives, food contact plastics and regenerated cellulose film.

6. Assessment and quantification of latex protein (LP) transfer from LP-containing contact materials into food and drink products (WPFCM/155)

6.1 *Dr Pradip Patel* (LFI) reported on work to determine the extent to which materials containing latex protein are used as contact materials in the food chain and to develop tools for monitoring latex allergens in food.

6.2 *Mr Wakelin* asked what level of allergen would be required to cause a reaction. *Dr Patel* explained that levels differed depending on the sensitivity of the individual.

6.3 *Mr Ashby* asked whether washing latex articles, such as gloves, could reduce the possibility of an allergic reaction by removing any potential migrants. *Dr Patel* believed this may be the case. Work is being undertaken as part of this project to determine if there is transfer to food.

6.4 *Dr Watson* requested further information on the amplification process, that was being used by LFI in analysing levels of latex allergen. *Dr Patel* explained the process utilised a peroxidase antibody in the final stages of the assay, to ensure the required levels of sensitivity and dynamic range were obtained.

7. Substances migrating from ion-exchange resins (WPFCM/156)

7.1 *Mr J Sidwell* (Rapra Technology Ltd) presented this project. He reviewed progress on investigating the use of ion-exchange resins in the food industry and the identification of any chemicals that could migrate into the food being processed.

7.2 *Dr Patel* commented that for an ion-exchange resin to be suitable for its selected use it must be washed with a buffer to equilibrate. He asked whether *Mr Sidwell* had encountered problems associated with monomers leaching from the resins as a consequence of washing at different pHs. *Mr Sidwell* responded that it depended on the resin type. If the functional groups are stable at the pH used then there is not a problem.

7.3 *Dr Castle* asked whether the ion-exchange resins encountered in the work to date had been disinfected prior to use, for example with formaldehyde. *Mr Sidwell* replied that this depended on their application. *Dr Castle* cited an example that had come to light during a previous FSA-funded project on the repair of glass fibre, reinforced plastic vats. This involved a small manufacturer not following recommendations on using and repairing the vats. He asked whether *Mr Sidwell* was aware of incorrect sterilants being used in connection with ion-exchange resins. *Mr Sidwell* replied that he was not but he had only visited larger manufacturers who were following established protocols.

7.4 *Mr Reynolds* asked whether the work was looking at ion-exchange resins used in single or mixed bed applications. *Mr Sidwell* confirmed the work was looking at both, for example for colour removal, beds can be mixed or used in sequence. *Mr Reynolds* asked whether re-generation in single beds would require additional flushing to avoid taint in the product. *Mr Reynolds* recalled a situation where using old and new resins in a mixed bed contributed to the growth of algae. *Mr Sidwell* explained that he had not encountered any such problems in the food industry. For example an industrial process he examined involved a throughput of 17 kilotonnes of sugar syrup per day. Such a high throughput reduces the possibility of algal growth. *Mr Reynolds* thought that it was a long time since he had seen any complaints regarding the contamination of sugar but he pointed out that only those instances where prosecution may be made were recorded by LACORS. Statistics regarding uninvestigated complaints were not compiled.

8. Chemical migration from adhesives used in food-contact materials and articles (WPFCM/157)

8.1 *Dr Emma Bradley* (CSL) reported on this research project. The work aims to determine the types of chemicals in adhesives used in food packaging and the extent to which they may migrate into food.

8.2 This work is in its early stages. The presentation was well received. A final report is expected in Summer 2005.

9. To identify chemicals in pigments and dyes that could migrate into foodstuffs and measure migration of these chemicals into food simulants (WPFCM/158)

9.1 *Mr Anthony O'Brien* (Pira International) introduced this research project which aims to obtain information about chemicals that may migrate from pigments and dyes used in plastic packaging into food.

9.2 *Mr Grayhurst* asked whether the work is examining coloured plastic packaging materials manufactured outside the EU. *Mr O'Brien* declared that it was not, however samples of plastic will be prepared which will incorporate colourants sourced from outside the EU.

9.3 *Mr Whitaker* asked whether pigments of Chinese origin comply with the Council of Europe Resolution on colourants. *Mr O'Brien* explained that the analytical work was still on-going. *Dr Barnes* informed the meeting that the solvent extraction stage of the work was not intended to mimic food contact situations, but a pre-requisite step prior to the assessing potential migration of the colourants from the selected plastics. She added that *Mr O'Brien* is examining worst-case scenarios and that if no migration is detected then it will not be necessary to examine packaging.

9.4 *Mr Reynolds* asked whether the plastic samples will be subjected to migration testing to mimic multiple re-use situations. *Mr O'Brien* confirmed that plaques will be selected and in some instances the surface abraded. In response to a question from *Mr Reynolds*, *Mr O'Brien* said he was not aware of a standard test to mimic abrasion caused by re-use. *Mr Reynolds* agreed to provide *Mr O'Brien* with the appropriate British Standard reference. **Action: Mr Reynolds**.

9.5 *Mr Ashby* asked whether there was any evidence of migration other than that which would be detected by chemical analysis. *Mr O'Brien* stated that screening is on-going but he had found one instance where staining had occurred.

9.6 *Dr Castle* pointed out that there is a difference between dyes and pigments, and that pigments would not be expected to behave in accordance with mathematical modelling as they are not soluble. *Mr O'Brien* agreed. *Mr Ashby* asked: whether, on moulding, the plastic acts as a solvent; and are the conditions of moulding stringent enough to dissolve the colourants? *Mr O'Brien* explained that the moulding process was not being investigated, just what migrated from the plastics.

10. Chemical migration from silicones used in connection with food contact materials and articles (WPFCM/159)

10.1 *Dr Martin Forrest* (Rapra Technology Ltd.) presented this paper reporting on progress: to provide detailed information on the types and composition of silicone based products that are used in contact with food; and to identify the extent to which migration of specific constituents into food could occur.

10.2 *Dr Castle* noted that the work had concentrated mostly on oligomers and recalled suggestions in the literature that dichlorobenzoyl peroxide used as an initiator could dimerise to form polychlorinated biphenyls. *Dr Forrest* confirmed that the major manufacturer with whom he has been in contact had therefore moved away from using that peroxide, adding that most silicones are now platinum-cured. *Dr Castle* agreed that many silicones used to be organotin-catalysed, but industry have moved away from this practice. He asked whether any organo-platinum compounds had been detected in the mixture. *Dr Forrest* thought that hexachloro platinum acids may have been used but the manufacturer had not disclosed this information. It is always difficult to detect an unknown. He agreed to further consider the use of organo-platinum compounds.

11. LC-MS method development for the screening of non-volatile and polar compounds present in paper and board and plastic food contact materials (WPFCM/160)

11.1 *Dr Laurence Castle* (CSL) presented this project. This research aims to develop methods that are able to identify and quantify 'unknowns' that can migrate from paper and board, and plastics into food.

11.2 *Mr Sidwell* asked whether *Dr Castle* was only using liquid chromatography-atmospheric pressure chemical ionisation-mass spectrometry. *Dr Castle* explained that initially particle beam ionisation was included in the work plan. However, due to the insensitivity of this technique, the schedule had been revised to include both negative and positive electrospray ionisation to complement the atmospheric pressure ionisation work.

12. An investigation of the breakdown products of curatives and antidegradants used to produce food contact elastomers (WPFCM/161)

12.1 This paper was noted.

13. Date of next meeting

13.1 The *Chairman* informed members that the Secretariat would trawl for a suitable date for the next meeting, which would probably be held in November.

SECRETARIAT

June 2004

ANNEX 3: THE FOOD STANDARDS AGENCY'S CURRENT RESEARCH PROGRAMME ON CHEMICAL MIGRATION FROM MATERIALS AND ARTICLES IN CONTACT WITH FOOD OR DRINK.

PROJECT TITLE	OBJECTIVE

Development of multi-methods for determining the migration of additives included in the proposed 6th amendment of Directive 90/128/EEC (A03031/ A03032)	To focus on the multi-methods suitable for the determination of antioxidants, biocides and organotin stabilisers listed in the amendment. Methodology for determining migration into foods is to be developed following foundation work utilising food simulants.
LC-MS method development for the screening of non-volatile and polar compounds present in paper and board and plastic food contact materials (A03037)	To investigate the application of LC-API-MS and LC-PB-MS for the identification and quantification of potential chemical migrants from these materials.
An investigation of the breakdown products of curative and antidegradants used to produce food contact elastomers (A03038)	To investigate the use of curatives and antidegradants in food contact rubber and the potential for the migration of breakdown products and cross-reactants from these starting ingredients.
Substances migrating from ion-exchange resins (A03042)	To investigate the composition and use of ion-exchange resins in the food industry, and their potential for migration to foodstuffs.
Assessment and quantification of latex protein (LP) transfer from LP-containing contact materials into food and drink products (A03043)	To determine the extent to which materials containing latex protein are used as contact materials in the food chain and to develop tools for monitoring the transfer, if any, of latex allergens to food and drink.
Chemical migration from adhesives used in food contact materials and articles (A03044)	To collate information on the use and composition of food contact adhesives and determine their potential for migration and, if applicable, the actual migration of these substances into simulants and foods.
To identify chemicals that could migrate into foodstuffs from pigments and dyes and measure migration of these chemicals into food simulants (A03045)	To obtain information about substances that may migrate from colourants in plastic materials coming into contact with food.

PROJECT TITLE	OBJECTIVE

Chemical migration from silicones used in connection with food contact materials and articles (A03046)	To provide information on the types and composition of silicone based products used in contact with food and identify the extent to which migration of specific constituents into food could occur.
Method development for the analysis of nonylphenol in different types of packaging (A03047)	To investigate the presence of nonylphenol in a range of different materials used to pack foods and quantify the levels present to allow an initial evaluation of food-packaging materials as a potential source of nonylphenols to food.
Investigation of migration from decorative shrink-sleeves (A03048)	To carry-out chemical analysis on shrink-sleeves used on packaged foodstuffs to identify the type of potential migrants, if any, associated with such heavily prnted materials.
An investigation of functional barriers currently used by the food industry and an assessment of their efficacy (A03049)	To provide the FSA with a list of materials, including plastics, used as barriers in food contact applications in the UK and the conditions for which they act as effective barriers.
An investigation of the stability of BADGE in foods and the reaction products formed (A03050)	To evaluate the current knowledge of the stability of BADGE in foods and the potential for reaction products to be formed with food components and to provide new knowledge and understanding on the chemical identity and nature of reaction products.
Measurement of packaged food intake by children by kilogram body weight to include type of packaging and foodstuff (A03051)	To investigate the food intake of UK children and the use of associated food contact materials. To determine if and how, the current EU model of 1 kg of packed food per 60 kg person per day should be modified to ensure specific protection against chemical migration into food marketed for children.