



**HAL**  
open science

# The estimation of exposure to food packaging material.1. The development of a food packaging database

Edel Duffy, Aine Hearty, Mary Gilsean, Michael Gibney

## ► To cite this version:

Edel Duffy, Aine Hearty, Mary Gilsean, Michael Gibney. The estimation of exposure to food packaging material.1. The development of a food packaging database. *Food Additives and Contaminants*, 2006, 23 (06), pp.623-633. 10.1080/02652030600627214 . hal-00577592

**HAL Id: hal-00577592**

**<https://hal.science/hal-00577592>**

Submitted on 17 Mar 2011

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**The estimation of exposure to food packaging material.1.  
The development of a food packaging database**

Journal:	<i>Food Additives and Contaminants</i>
Manuscript ID:	TFAC-2005-327.R1
Manuscript Type:	Original Research Paper
Date Submitted by the Author:	03-Feb-2006
Complete List of Authors:	Duffy, Edel; Institute of European Food Studies, Clinical Medicine Hearty, Aine; Insititute of European Food Studies, Clinical Medicine Gilsenan, Mary; Institute of European Food Studies, Clinical Medicine Gibney, Michael; Institute of European Food Studies, Clinical Medicine
Methods/Techniques:	Exposure
Additives/Contaminants:	Food contact materials
Food Types:	

SCHOLARONE™  
Manuscripts

## The estimation of exposure to food packaging materials. 1. The development of a food packaging database

### Abstract

A food packaging database was developed to provide qualitative information on the types of packaging materials used for foods. Packaging information was collected from a sample of 594 children aged 5-12 years as part of a national children's food survey carried out in Ireland during 2003-2004. All of the food packaging collected during this survey was forwarded to the coordinating centre for further analysis and entry into the Irish Food Packaging Database. This database was created in Microsoft Access<sup>®</sup>, and stored information on the brand of the food, the packaging type, the unit weight, the contact layer, the EU food type (i.e. aqueous, acidic, alcoholic or fatty) and other relevant parameters. Of the 5551 different brand foods consumed by children in the food survey, packaging information was collected on 3441 (62%). As some brand foods had different unit weights and packaging formats there was duplication of some brand foods in the database to account for this. Therefore, there were a total of 3672 packaging entries in the database. Of these plastics were the most common packaging contact layer (n=2874, 78.3%). Multimaterial multi-layers with a plastic contact layer accounted for 459 (12.5%) entries. Polyethylene was the most frequently used contact layer (n=941) with polypropylene a close second (n=809). This database is unique in Europe for the quality and amount of food packaging information it contains and could be used to develop packaging use factors for a more refined exposure assessment to food packaging materials in the EU.

### Introduction

At present, the assessment of exposure to migrants from food contact materials in the EU is based on a crude method. This crude and conservative method assumes that 1kg of food packaged in 6 dm<sup>2</sup> of the material of interest is consumed per individual each day over a lifetime. It also assumes that migration occurs at the maximum permitted level. More refined methods are available for the estimation of exposure to other food chemicals such as the international estimated daily intake (IEDI) for pesticide residues (WHO 1997) or the estimated daily intake (EDI) for food additives (FAO/WHO

1  
2  
3 1989). In addition to differences in exposure assessment methods, the regulation of  
4 food packaging materials is different to that of other food chemicals. For example, the  
5 use of a food additive is permitted only in specific foods and the maximum level of  
6 use in each food is governed by legislation. In contrast, once a chemical is permitted  
7 for use in plastic packaging, it can be used in any plastic packaging, which in turn can  
8 be used for any food once safety and migration limits are not exceeded.  
9  
10  
11  
12  
13  
14

15  
16 It is recognized that more refined exposure estimates are needed in the EU for  
17 migrants from food packaging material (ILSI 1996, Svensson 2002, Gibney 2004).  
18 One of the key elements needed to refine the exposure assessment of food packaging  
19 material migrants is the capacity to link the use of a specific food packaging type to  
20 the consumption of a specific food item. This information permits the likelihood that a  
21 chemical migrant is present in a food to be assessed. One of the best ways to gather  
22 comprehensive packaging data on foods consumed by the population is to collect  
23 packaging information as part of a national food consumption survey. This aspect of  
24 data collection has been an objective of national food surveys carried out in Ireland  
25 over the past number of years. To provide accurate information on the types of  
26 packaging used for foods, an Irish Food Packaging Database (IFPD) was constructed  
27 in conjunction with the National Children's Food Survey (NCFS), which was  
28 conducted between 2003-2004. This food survey collected detailed consumption  
29 information that is, by and large, consistent with the level of detail recently proposed  
30 by the European Food Safety Authority (EFSA) for food chemical exposure  
31 assessment (EFSA 2005). The aim of the food packaging database was to store  
32 information on type of packaging used for different foods so that data from this  
33 database could be combined with food consumption data to determine consumption  
34 factors for the different types of packaging used. The collection of food packaging  
35 information is continuing in Ireland with the collection of packaging materials as part  
36 of the National Teen Food Survey, which commenced in 2005 and which will gather  
37 such data on 13-17 year olds ([www.iuna.net](http://www.iuna.net)).  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55

56 The overall aim of this data collection is to enhance the estimation of exposure to food  
57 packaging migrants in the population, however this process has a number of different  
58 phases. The first is the collection of information on the exact packaging type (e.g.  
59 rigid plastic bottle) and contact layers used for foods. The second is to link this  
60

1  
2  
3 information with actual consumption of these foods. The third is the estimation of the  
4 level of chemical migrants, from the food packaging, in the food. The present paper  
5 describes the first phase of this process, that is, the collection of information on the  
6 packaging used for different foods. Future work will describe the consumption level  
7 of packaged food and the application of this data to complete exposure assessments to  
8 packaging migrants.  
9  
10  
11  
12  
13

## 14 15 16 **Methodology**

### 17 *Data collection for the Irish Food Packaging Database*

18 Food packaging information was collected as part of the NCFS conducted in Ireland.  
19 The NCFS collected information on 594 Irish children aged between 5-12 years. This  
20 study was a 7-day food intake survey that collected quantitative food intake data,  
21 physical activity measurements, lifestyle information, attitudes, and packaging  
22 information (e.g. unpackaged or the type of packaging used). The subjects recorded  
23 the type (e.g. strawberry yoghurt), brand (e.g. Mr. X strawberry yoghurt) and amount  
24 of food consumed and also the type of packaging material used and the unit weight of  
25 the food product. This data collection included packaging information on ingredients  
26 used in homemade recipes. All of the packaging collected in the course of the study  
27 was forwarded to the coordinating centre for analysis. The correct contact layer i.e.  
28 plastic, glass, metal and alloys, paper and board or a combination of these was  
29 identified for entry into the packaging database. Where packaging information was  
30 incomplete in the survey diaries or where the packaging material was not collected,  
31 data were sought from supermarket audits, online shopping facilities and, where  
32 necessary, purchase of the food. The latter was undertaken only when (a) the brand  
33 was consumed at least nine times in the survey and (b) there were no data on the  
34 packaging material used.  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49

### 50 51 *Construction of the Irish Food Packaging Database*

52 The IFPD database was created in Microsoft Access<sup>®</sup>, Microsoft Office 2000 SR-1  
53 Professional for Windows (Microsoft Corporation, Redmond, WA, USA). A number  
54 of tables were created in the database to store information on brand foods and their  
55 packaging type, the EU classification (i.e. aqueous, acidic, alcoholic or fatty)  
56 according to Council Directive 85/572/EEC and the suitable test conditions (e.g. 10  
57 days at 40 °C) according to Council Directive 82/711/EEC.  
58  
59  
60

### *Data entry into the Irish Food Packaging Database*

For each food packaging item entered into the IFPD, information was recorded on a number of different parameters that described the product type and the packaging type (Table 1). There were two grouping systems used in the database to classify entries. The first, the food packaging group, was used to group similar food types that had similar packaging types, for example, “bread (brittle clear plastic)”, “bread (paper)” and “bread (soft clear plastic)”. This grouping scheme was designed to aid identification of the contact layer and to ensure representative samples were sent for further analysis for exact contact layer identification. These groups were also used at the start of data collection to distinguish and describe the packaging material prior to more precise identification. Packaging samples were assigned to packaging groups based on visual inspection. The second grouping system, food group, was used to group foods of similar type with similar storage conditions, for example, “processed foods, chilled” or “processed foods, frozen”.

[Insert Table 1 about here]

### *Reference library*

A digital photograph was taken of all the packaging samples collected. These were filed according to their appropriate packaging group. A 3-4cm<sup>2</sup> sample was cut from each packaging sample and stored for future reference before the remainder of the packaging was discarded. Microbially contaminated or otherwise unsuitable samples (e.g. duplicate samples or samples that were badly torn) were not stored.

### *Contact layer identification*

Although identification of the crude packaging type (i.e. paper and board, plastic, metal and glass) was documented in the IFPD, information on the exact material used for the contact layer was also collected. A number of different methods were used to collect information on the exact contact layer of the packaging that could not be identified by visual inspection.

#### *(i) Information on the packaging*

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

In cases where the type of polymer used to make the plastic packaging was identified on the package, it was recorded in the database. The type of polymer is often identified on packaging for recycling purposes and this information is located on the food label or embossed into the plastic. If the plastic packaging type was not identified on the pack, information from manufacturers was sought (ii) or further analyses were completed (iii).

*(ii) Manufacturers information*

Some 34 food companies were contacted and requested to forward data on the contact layer material used for specific foods. Of these 17 responded and these included some very large food companies covering many individual brands. To encourage a reasonable response, all companies were offered a non-disclosure agreement by the investigator. In addition to food companies, one packaging manufacturer was contacted to provide information on the exact contact layer used for their packaging.

*(iii) Infa-red analysis*

The third method used to identify contact layers was Attenuated Total Reflectance Fourier Transform Infa-Red (ATR-FTIR) techniques. These analyses were conducted at the Polymer Development Centre, Trinity College Dublin, Ireland, using a Nicolet NEXUS Model 470/670/870 bench with a zinc selenide crystal. Where necessary, samples were analysed on a Nicolet Continuum Microscope (Spectra Tech Continuum Model No. 912A0429) using a germanium crystal. The objective of the analysis was to identify the inner surface of the packaging sample. This process provided a spectrum of the uppermost two microns of the surface of the sample polymer. In this way, the food contact layer was analysed without any interference being present from subsequent polymer layers that may be present in the packaging film. Although multilayer plastic films may have been used for the food packaging and migration may occur from these other layers, due to resource constraints, only the contact layer/coating of the plastic packaging was identified using ATR-FTIR. Samples were sent for ATR-FTIR analyses if no contact layer information was available on the packaging itself or from manufactures. Samples were chosen from the different “food packaging groups” to ensure a

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

representative batch of packaging materials used for different foods were identified. Some food packaging samples were identified by both ATR-FTIR and the food manufacturer. In the majority (>80%) of these cases both sources identified the same polymer as being in contact with the food, however a small number of co-polymers (n=8) caused some discrepancy.

## Results

A total of 3672 branded food items and their packaging types were entered into the database. Of these entries, 1904 (52%) were food packaging items directly collected in the course of the survey while 1768 (48%) of them were entered after collecting information on the packaging type from the supermarket shelf audits, online shopping facilities or by purchasing the foods consumed in the NCFS.

Plastic packaging was the most common contact layer used with 2787 (75.9%) of all entries having plastic as the sole contact layer (Table 2). When packaging was used in combination with other contact layers, the percentage of entries with a plastic contact layer increased marginally to 2874 (78.3%). The next most popular contact layers were paper and board (n=270, 7.4%) and metal and alloys (n= 261, 7.1%). As can be seen from Table 2, there were a number of packaging formats used for foods where a combination of different materials were in contact with the food (n=350, 9.3%). In addition there were 173 (4.7%) entries that had more than one type of polymer in contact with the food (results not shown). Multimaterial multilayers, as determined by visual inspection, were commonly used for food packaging (n=498, 13.6%). Of these multimaterial multilayers 459 (92%) had plastic contact layers.

Of the 2874 food packaging items that had one or more plastic contact layers, data on polymers used were available for 2211 (77%) items. Of these 2211 food packaging items, 54 had 2 plastic contact layers that were identified during the analysis. Therefore 2265 (2211 + 54) polymer contact layers were identified in total. These data are given in Table 2. Polyethylene (PE) was the most frequently used contact layer (n=941, 41.6%) while polypropylene (PP) was a close second with (n=809, 35.7%) entries having a contact layer made from this polymer. Other polymers identified as contact layers included polyethylene terephthalate (PET), polystyrene (PS), polyvinyl chloride (PVC), polyvinylidene chloride and polyamide.

1  
2  
3  
4  
5  
6  
7 [Insert Table 2 about here]  
8  
9

10 To gain further insight into the distribution of contact layers used for different food  
11 products, an analysis was completed on the 26 food groups listed in Table 3. Plastic  
12 was used in all food groups. Some of the groups that had a majority of entries as  
13 plastic contact layers included “chocolate confectionery”, “sugar confectionary”,  
14 “crisps, nut and snacks”, “processed meats”, “cereal and cereal products” and “liquid  
15 beverages non-alcoholic”. Some groups that differed from this trend included “Jams  
16 and spreads”, which were more commonly packaged in glass containers with metal  
17 lids (n=82, 78%) or glass jars with plastic lids (n=22, 21%). Also “Processed foods  
18 and meals stored at ambient temperatures” were commonly packaged in cans (n=138,  
19 56%) or glass jars with metal lids (n=68, 28%). This group included processed and  
20 canned fruit and vegetables, savoury sauces and canned soups. Items in the “Fruit  
21 (fresh & dried)” and “Vegetables (fresh)” groups had a high percentage of entries with  
22 plastic as the contact layer at 71 (90%) and 76 (87%), respectively. However this  
23 percentage is only for packaged fruit and vegetables and does not account for fruit and  
24 vegetables that are bought not packaged or loose.  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38

39 [Insert Table 3 about here]  
40  
41  
42  
43  
44  
45

46 To investigate the type of polymers used for different food groups, analysis was  
47 completed on the frequency of use of polymers as contact layers for the 26 food  
48 groups (Table 4). No polymers were identified for food groups “jams and spreads” or  
49 “bakery products”. For “Chocolate confectionary” PP was the only polymer  
50 identified while for “Fish & seafood (fresh & frozen & processed)” PE was the only  
51 polymer identified. PS was a popular contact layer for the “Dairy products” group due  
52 to PS being used for yoghurt pots (n=93, 46%). PET (n= 307, 51%) and PE (n=289,  
53 48%) had a high frequency in the "Liquid beverages non-alcoholic" group. This was  
54 due to the high frequency of fruit juice and carbonated drinks in the database (this  
55 group also contained water and milk). Fruit juices were commonly packaged in a  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

multimaterial multilayers, which had a PE contact layer and carbonated beverages were routinely packaged in PET bottles.

[Insert Table 4 about here]

A number of methods were used to identify the exact polymer used as the contact layer. The majority of polymer contact layers were identified from information provided by the food companies (n=687, 30.5%) (Table 5). Information on the packaging was also a valuable source of polymer identification (n=661, 29.4%). Food groups that had the polymer type identified on their packaging included carbonated soft drinks and squashes, fat spreads, yogurts and confectionary. Packaging samples that were not actually analysed by ATR-FTIR but whose contact layer could be identified based on visual inspection of the material by experts and on the basis of similar entries being identified by the polymer development centre, were coded separately in the database. The total contact layers identified by this combined method of the polymer development centre and expert opinion based on information provided the polymer development centre was 618 (26.7%).

[Insert Table 5 about here]

### Discussion:

The IFPD is unique in Europe in terms of the level and quality of food packaging information it contains. The development of this database as an add-on to the NCFS (incremental cost of approximately 10%) has proved successful and is the first packaging database created to directly link with a food consumption survey to gain insight into the distribution and types of food packaging used. The information recorded in this database provides valuable details on the types of foods that are packaged and the packaging types that are used. This information is vital so that more realistic estimates of exposure to food packaging migrants can be developed as part of the ever-developing discipline of exposure assessment.

The NCFS of which the present study was a component meets all of the requirements of food consumption surveys as recently proposed by EFSA (EFSA 2005), including their use for the estimation of nutrient intakes and the intake of food chemicals

1  
2  
3 including food contact materials. Although this paper focuses on the types of  
4 packaging used for foods, information was recorded in the packaging database on the  
5 EU food category (i.e. aqueous, acidic, alcoholic and fatty) and migration test  
6 conditions of the foods. This ensures that the combination of the food survey and the  
7 packaging database will aid the further development of exposure modelling of food  
8 packaging migrants.  
9  
10  
11  
12  
13

14  
15  
16 Other databases have been developed to store information on the type of packaging  
17 used for foods. Maurice Palmer Associates (MPA 1995) developed a database from  
18 the results of a number of studies on the use of food packaging material mainly  
19 focused on the UK and Italy. This database was discussed at a workshop of ILSI  
20 Europe Packaging Material Task Force (ILSI 1996). Although information on food  
21 type, package size, packaging material and contact coating was collected as part of  
22 this study, these data were not related to actual use of packaging ascertained through a  
23 national food intake survey. The data collected from the UK and Italy were  
24 extrapolated to the then 15 EU Member States based on a number of assumptions.  
25 Because of these assumptions, the confidence in the data produced was estimated to  
26 vary from a low of about 60% for Ireland, Finland and Sweden to a high of 90% for  
27 the UK market (ILSI 1996). Other databases that store information on packaging  
28 used for foods include the Dutch Grootverbuik Product Informatie database  
29 established in 1995 by a number of wholesalers who provide food to the catering,  
30 hospital and restaurant industries ([www.gpi.nl](http://www.gpi.nl)). Although this database contains  
31 packaging descriptions for over 12 000 articles and is continuously being updated it is  
32 for foods sold at wholesale level and not retail level. Therefore it lacks information on  
33 foods bought and consumed by the public. The Dutch EAN DAS is a not-for-profit  
34 datapool for Fast Moving Consumer Goods (FMCG) established in 2000 and collects  
35 information on packaging formats used for products. They have packaging  
36 information on over 63 000 FMCG of which approximately 35% are food products  
37 ([www.eandas.nl](http://www.eandas.nl)). The quality of packaging information recorded in this database  
38 ranges from crude (e.g. box) to more specific (e.g. polypropylene bag). Another  
39 source of food packaging information is commercial food and consumer databases  
40 that monitor trends in the consumer product market. The Mintel Global New Products  
41 Database ([www.gnpd.com](http://www.gnpd.com)) monitors worldwide consumer packaged goods markets  
42 and covers the food, beverage and non-food sectors. The Innova Food and Beverage  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 database also collects information on ingredients, packaging and formulation of foods  
4 and beverages ([www.innova-food.com](http://www.innova-food.com)). Again the level of packaging information in  
5 these databases ranges from crude to more specific. The German Association for  
6 Packaging Market Research (GVM) also collate data on the packaging types used for  
7 foods (R Franz, personal communication, 2005). This data is collected at retail level  
8 and not at food consumption level. Overall these databases are a useful resource of  
9 general packaging information. However information is not routinely recorded on the  
10 exact contact layer used for the food, the polymer type if the packaging is plastic or if  
11 the packaging is a multilayer. It is this level of detail that is needed to refine exposure  
12 assessments to chemical migrants from packaging materials. Also, these databases  
13 were not created to directly link with food consumption data and therefore give an  
14 overview only of the types of packaging used for foods available on the market but  
15 not the packaging used for foods that are actually purchased and consumed by  
16 individuals.  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29

30 Few difficulties arose during the development of the IFPD. However, collecting  
31 information on the polymers used as contact layers was the most time consuming  
32 aspect. Identification of these contact layers used for the packaging was sought from  
33 a number of different sources. Food manufacturers proved to be a very useful source  
34 of information, once followed up with emails and phone calls. Although a large  
35 number of polymer types used for the food contact layer were identified from the  
36 packaging, from food manufacturers and from a packaging manufacturer, there were a  
37 large number of food packaging items that needed further identification. Only some of  
38 these were identified by ATR-FTIR due to the cost involved to obtain a complete data  
39 set. One limitation in using ATR-FTIR alone to identify the polymer is with the case  
40 of co-polymers. If the signal from one of the co-polymers is saturated or swamped by  
41 that of the second co-polymer a co-polymer will not be identified, as only the  
42 dominant spectrum will be analysed. Difficulties may arise with identification of  
43 packaging samples due to the history of that individual sample, such as grease being  
44 present on the surface contact layer, or perhaps the inner layer being removed or worn  
45 away before it was collected and tested. Also the ATR-FTIR scanned only the first  
46 two micrometers of the surface contact layer and not the whole plastic film. This point  
47 should be borne in mind when determining the probability of presence of a migrant in  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 a food and also the level at which it is present, as migration may occur from the layers  
4 beyond the polymer surface layer.  
5  
6  
7

8  
9 When the frequency of contact layers used was established the polyolefins, PE and PP  
10 were the main polymers used in contact with foodstuffs. These results are similar to  
11 those found in a Dutch study completed in 1997 (Van Lierop 1997, Bouma et al.  
12 2003). For example, PE and PP were the main materials in contact with foods in both  
13 studies. Also, PP was the main material used for confectionary in both studies. The  
14 Dutch study was designed to gain information on which materials were used in  
15 contact with foods and to collect information on the size of the packaging used for the  
16 food. It was not designed to estimate consumption of foods packaged in these  
17 materials. The popularity of PE and PP for food packaging applications is due to their  
18 relatively low cost, their range of versatile properties and the ease in which they can  
19 be processed into different packaging forms (Tice 2002 & Tice 2003). There are a  
20 number of types of PE polymer. The different types include low density polyethylene  
21 (LDPE), liner low density polyethylene (LLDPE) and high density polyethylene  
22 (HDPE). For ease of analysis, all these types were classified as PE. However, details  
23 on the exact type of PE are documented in the IFPD.  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36

37 Every effort was made to collect comprehensive information on the packaging used  
38 for foods consumed by children in Ireland. However, it should be noted that most of  
39 the packaging collected by the children in the NCFS was packaging for products sold  
40 at retail level. Information was not collected on the packaging used in catering  
41 establishments. Therefore the IFPD does not contain a complete history of all  
42 packaging that may have been in contact with the food or food ingredients, though  
43 packaging information on homemade recipes and takeaway foods was collected.  
44 However to put the number of eating occasions by children in catering establishment  
45 in perspective, in a study completed on the NCFS it was found that only 2% of eating  
46 occasions were in catering establishments which contributed to only 3.2% of total  
47 energy intake (Burke 2005). Information was collected on most food groups available  
48 on the Irish market with the exception of alcoholic products as the NCFS collected  
49 information on children aged between 5-12 years. Also it was not within the remit of  
50 this project to collect information on the surface area of the packaging in contact with  
51 the food. Despite these limitations the database provides a huge amount of  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 information regarding the frequency of use and trends of packaging used for food  
4 groups on the Irish market. This work reduces the uncertainty regarding the types of  
5 packaging used for foods and therefore when completing an exposure assessment the  
6 overall uncertainty of the assessment is reduced. However other areas of uncertainty  
7 that may need to be reduced in the exposure assessment are the probability that the  
8 migrant is present in the food and the level at which it is present.  
9  
10  
11  
12  
13

14  
15  
16 Exposure assessments are completed as part of the safety assessment of substances. In  
17 terms of regulatory compliance most materials and articles are not covered by specific  
18 legislation but by the framework regulation (EC) No 1935/2004. Article three of this  
19 regulation specifies that materials and articles should not transfer substances into food  
20 in concentrations that may pose a risk to human health. Except for plastics,  
21 regenerated cellulose, lead and cadmium in ceramics, bisphenol A diglycidyl ether  
22 (BADGE), nitrosamines and nitrosable substances in rubber teats, no legal limits are set  
23 to indicate the concentration that does not pose a risk to human health. It is the  
24 responsibility of the producer to complete the risk assessment for the material or  
25 article. The risk assessment process is composed of four elements- hazard  
26 identification (i.e. identification of permitted monomers and additives; identification  
27 of non intentionally added substances- impurities, reaction intermediates and  
28 decomposition products; identification of additives not covered by the positive list  
29 such as colourants and polymerisation production aids), hazard characterisation  
30 (toxicology data) and exposure assessment. These three elements combined enable  
31 risk characterisation to be completed and hence complete the risk assessment process.  
32 If the producer has toxicology data and concentration data this is a first indication of  
33 the safety of the substance. However the potential for the substance to be a safety  
34 hazard in the human diet is determined based on the amount of the substance  
35 consumed. If the food packaging applications of this substance are known then the  
36 data in this study can help determine what foods the substance may be present in and  
37 consumption data of these foods can then be used to refine the exposure assessment.  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55

56 If future plastic regulations are broadened to cover multimaterial multilayers that contain  
57 a plastic food contact layer it means that the specific migration level (SML) or the  
58 overall migration level (OML) will have to take account of any migration from non-  
59 plastic components of the multilayer, in addition to the migration from plastics  
60

1  
2  
3 (Heckman 2005). In the present study there were 498 entries (13.6%) that were  
4 multimaterial multilayers with 459 of these with plastic contact layers (92%). This  
5 figure demonstrates the prominence of multimaterial multilayers that have plastic as  
6 the food contact layer and needs to be borne in mind when considering the impact for  
7 compliance testing if such regulations are implemented.  
8  
9  
10  
11

12  
13  
14  
15  
16  
17 In conclusion, the collection of food packaging materials as part of a national food  
18 survey has enabled the development of a food packaging database, which is unique in  
19 Europe. The methodology used to construct this database has proved efficient and  
20 will allow further analysis of the packaging types used for foods consumed by  
21 children and the development of food packaging consumption factors. Data entry into  
22 the database will continue as more packaging material is collected in the National  
23 Teen's Food Survey and will therefore be an up-to-date source of packaging  
24 information for the foreseeable future.  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36

### 37 **References**

38  
39 Bouma K, Stavenga K, Draaijer A. 2003. Domestic use of food packaging materials in  
40 the Netherlands. Report NDFCM010/01. Available:  
41 [http://www.vwa.nl/download/rapporten/Voedselveiligheid/20041019\\_food\\_%20pack](http://www.vwa.nl/download/rapporten/Voedselveiligheid/20041019_food_%20packaging_materials.pdf)  
42 [aging\\_materials.pdf](http://www.vwa.nl/download/rapporten/Voedselveiligheid/20041019_food_%20packaging_materials.pdf) via the INTERNET. Accessed 2005 October 11.  
43  
44  
45  
46  
47

48 Burke S. 2005. A study of food consumption patterns of children and adults in  
49 Ireland: Implications for the development of food based dietary guidelines. Trinity  
50 College Dublin. 128p.  
51  
52  
53  
54  
55  
56  
57

58 EFSA 2005. European Food Safety Authority (EFSA). Scientific Colloquium on  
59 European Food Consumption Database: Current and medium to long-term strategies,  
60 April 2005. Available:

1  
2  
3  
4 [http://www.efsa.eu.int/science/colloquium\\_series/col\\_consumption/824\\_en.html](http://www.efsa.eu.int/science/colloquium_series/col_consumption/824_en.html) via  
5 the INTERNET. Accessed 2005 October 28.  
6  
7  
8  
9

10 European Commission 2002. European Commission Directive 2002/72/EC of 15<sup>th</sup>  
11 August 2002 relating to plastic materials and articles intended to come into contact  
12 with foodstuffs. Official Journal of the European Union L220, 15.08.2002, p.18,  
13 corrigendum OJ L39, 13.02.2003, p1.  
14  
15  
16  
17

18  
19 European Commission 2004. Directive 2004/Regulation (EC) No 1935/2004 of the  
20 European Parliament and of the Council of 27 October 2004 on materials and articles  
21 intended to come into contact with food and repealing directive 80/590/EEC and  
22 89/109/EEC. Official Journal of the European Union. 13.11.2004 L338/4.  
23  
24  
25  
26  
27

28 European Council 1982. European Council Directive 82/711/EEC of the 18 October  
29 1982 on laying down the basic rules necessary for testing migration of the constituents  
30 of plastic materials and articles intended to come into contact with foodstuffs. OJ  
31 L297, 23.10.1982, p.26.  
32  
33  
34  
35  
36

37 European Council 1985. European Council Directive 85/572/EEC of the 19 December  
38 1985 on laying down the list of simulants to be used for testing migration of  
39 constituents of plastic materials and articles intended to come into contact with  
40 foodstuffs. OJ L372, 31.12.1985, p14.  
41  
42  
43

44 FAO/WHO (Food and Agricultural Organization of the United Nations, World Health  
45 Organization) 1989. Guidelines for the simple evaluation of food additives intake.  
46 Supplement 2 to the Codex Alimentarius volume XIV (Rome:FAO/WHO).  
47  
48  
49  
50

51 Gibney MJ. 2004. Realistic estimates of migrants from food packaging materials. Oral  
52 presentation from the 3<sup>rd</sup> International Symposium on Food Packaging Available:  
53 <http://europe.ilsa.org/misc/isfp/oralpresentations/1-1%20Gibney.pdf> via the  
54 INTERNET. Accessed 2005 October 28.  
55  
56  
57  
58  
59  
60

1  
2  
3 Heckman JH. 2005. Food packaging regulation in the United States and the European  
4 Union. *Regulatory Toxicology and Pharmacology* 42:96-12  
5  
6  
7

8  
9 International Life Sciences Institute (ILSI) 1996. Food Consumption and Packaging  
10 Usage Factors- Summary of a Workshop held in July 1996. Available:  
11 <http://europe.ilsilife.org/file/ILSIFCon.pdf> via the INTERNET. Accessed 2005 October  
12 11.  
13  
14

15  
16  
17 Maurice Palmer Associated Ltd. (MPA) 1995. Assessment of Food Exposure to  
18 Packaging in EU Countries Report.  
19  
20  
21

22  
23 Svensson K. 2002. Exposure from food contact materials. Summary report of a  
24 workshop held in October 2001 in Ispra, Italy. Organised by the ILSI Europe  
25 Packaging Material Task Force in Collaboration with the European Commission's  
26 Joint Research Centre. Available: <http://europe.ilsilife.org/file/exposurefoodcontact.pdf>  
27 via the INTERNET. Accessed 2005 October 11.  
28  
29  
30  
31

32  
33 Tice P. 2002. Packaging Materials: 3. Polypropylene as a packaging materials for  
34 foods and beverages. Available: <http://europe.ilsilife.org/file/3-RPPM3Polyprop.pdf> via  
35 the INTERNET. Accessed 2005 October 11.  
36  
37  
38  
39

40  
41 Tice P. 2003. Packaging Materials 4. Polyethylene for food packaging applications.  
42 Available: [http://europe.ilsilife.org/file/PM4\\_Polyethylene.pdf](http://europe.ilsilife.org/file/PM4_Polyethylene.pdf) via the INTERNET.  
43 Accessed 2005 October 11.  
44  
45  
46

47  
48 Van Lierop JBM. 1997. Enforcement of food packaging legislation. *Food Additives*  
49 *and Contaminants* 14:555-560.  
50  
51

52  
53 WHO 1997. Guidelines for predicting dietary intake of pesticide residues. Prepared by  
54 the Global Environment Monitoring System- Food Contamination Monitoring and  
55 Assessment Programme (GEMS/Food) in collaboration with Codex Committee on  
56 Pesticide Residues. WHO/FSF/FOS/97.  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

For Peer Review Only

**Table 1. List of parameters and their description recorded in the Irish Food Packaging Database**

Parameter	Description	Example
Brand code	Each entry in the packaging database was assigned a brand code. Of the 5551 brand codes in the National Children's Food Survey, 3441 had corresponding entries in the packaging database. A unique brand code was assigned to a food packaging item if it was a new brand or a new flavour of the brand food. As different unit weights and packaging formats of the same brand food may exist, these items were also entered into the database. Therefore there were a total of 3672 entries in the packaging database.	121
Brand name	Each brand code had a brand name documented in the packaging database. This was the product name used on the food label.	Mr. X Chocolate Biscuit
Unit weight	Unit weight represented the weight of the food product as packaged. If the food product was part of a multipack and packaged individually then the unit weight of the individual item was recorded.	200g
Description of packaging type	This was a general description of the packaging material based on visual inspection. It also included a description of secondary packaging if present (e.g. outer cardboard box).	White plastic wrapper
Food packaging group	Foods of similar type with similar packaging type were grouped together.	Biscuit & Cakes White Plastic
Food group	This food group classification was developed to allow similar types of foods with similar storage conditions to be grouped together. Twenty-six of these food groups were created in total (see Table 3).	Biscuit
Contact layer information	The exact material or polymer in contact with the food was recorded if identified. If there were two or more contact layers used for a food item both were recorded.	Polypropylene
Identifier of contact layer	The method by which the contact layer was identified was recorded.	Polymer Development Centre (ATR-FTIR)
Date of contact layer identification	The date on which the contact layer was identified was recorded. This is to ensure the packaging database remains up-to date as the packaging used for different brand foods main change in the future.	20-08-2004
Presence of multimaterial multilayer	In the present study the term multimaterial multilayer refers to packaging made with more than one layer and the layers are made from different materials (e.g. an outer plastic layer, a middle paper and board layer and an inner plastic layer). This was determined by visual inspection. It was not used to record multilayers where each layer was made from plastic.	No
EU food category	The food was classified into one of the EU food categories- acidic, alcoholic, aqueous or fatty (Council Directive 85/572/EEC).	D (Fatty)
Migration test conditions	The appropriate conditions of migration testing were assigned to each food (Council Directive 82/711/EEC).	10 days at 40 <sup>0</sup> C
Sample Present	Not all entries in the packaging database had their sample stored (e.g. samples that were microbially contaminated were not stored). If the packaging sample for a food item was retained and stored this was documented in the database.	Yes, sample present

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

For Peer Review Only

**Table 2. Frequency of packaging formats used as contact layers in the Irish Food Packaging Database**

<b>Packaging Formats</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>
<b>Single contact layer formats</b>		
Metal and alloys	261	7.1
Paper and board	270	7.4
Plastic	2787	75.9
Wax	1	0.0
<i>Subtotal</i>	<i>3319</i>	<i>90.4</i>
<b>Combination of contact layer formats</b>		
Glass and metal and alloys	163	4.4
Glass and plastic	40	1.1
Metal and alloys and plastic	8	0.2
Metal and alloys and paper and board	100	2.7
Paper and board and plastic	39	1.1
<i>Subtotal</i>	<i>350</i>	<i>9.3</i>
Missing information	3	0.1
<b>Total</b>	<b>3672</b>	<b>100.0</b>
<b>*Plastics</b>		
Polyethylene (PE)	941	41.6
Polypropylene (PP)	809	35.7
Polyethylene terephthalate (PET)	358	15.8
Polystyrene (PS)	126	5.6
Polyvinyl chloride (PVC) and polyvinylidene	19	0.8
Others (e.g. Polyamide, polyvinylacetate)	12	0.5
<b>Total polymers identified</b>	<b>2265</b>	<b>100</b>

\* All polymers used for plastics in the database were not identified. Therefore the "total polymers identified" represents only those plastics where the polymer contact layer was identified.

Table 3. Frequency of use of packaging materials used as contact layers in the Irish Food Packaging Database

Food Group	N	Plastic		Paper & Board		Metal & Alloys		Plastic & Paper		Wax		Glass & Metal & Alloys		Glass & Plastic		Metal & Alloys & Paper		Metal & Alloys & Plastic	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Chocolate confectionary	248	176	71	17	7	54	22	1	0.4										
Sugar confectionery	181	126	70	52	29	3	2												
Ice-cream	91	76	84	15	16														
Jams and spreads	105	1	1									82	78	22	21				
Crisps, nuts and snacks	169	166	98	3	2														
Sweet & savoury biscuits	153	146	95			3	2	4	3										
Pies, pastries and cakes	73	37	51	11	15			18	25							2	3	5	7
Bread	233	167	72	59	25			7	3										
Bakery products	6	2	33	4	67														
Cereal and cereal products	173	167	97	6	3														
Dry Rice, pasta and noodles	91	79	87	12	13														
Fish & seafood (fresh & frozen & processed)	52	22	42			30	58												
Fresh meat (chilled & frozen)	39	38	97	1	3														
Processed meat	228	208	91	14	6	2	1	2	1									2	1
Cheese & cheese products	84	70	83			6	7			1	1							7	8
Dairy Products	220	137	62	10	5			5	2										68
Oils	2	1	50									1	50						
Fruit (fresh & dried)	79	71	90	2	3	5	6	1	1										
Vegetables (fresh)	87	76	87	11	13														
Liquid beverages non-alcoholic	625	602	96			16	3					7	1						
Dried beverages tea and coffee	34	6	18	21	62	2	6							4	12	1	3		
Processed foods and meals, ambient moist	245	32	13	2	1	138	56					68	28	5	2				
Processed foods and meals, chilled	29	24	83									2	7			1	3	2	7
Processed foods and meals, frozen	193	182	94	8	4											1	0.5	2	1
Processed foods and meals, dehydrated	181	156	86	8	4	5	3	1	1					2	1	3	2	6	3
Other (eggs, nutritional supplements & takeaway food)	48	19	40	11	23							3	6	7	15			8	17

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

For Peer Review Only

**Table 4. Frequency of polymer types used as contact layers for food groups in the Irish Food Packaging Database**

Food Group	N*	Polyethylene		Polypropylene		Polyethylene terephthalate		Polystyrene		Polyvinyl chloride and polyvinylidene		Other	
		n	%	n	%	n	%	n	%	n	%	n	%
Chocolate confectionary	119			119	100								
Sugar confectionery	55	11	20	43	78	1	2						
Ice-cream	53	7	13	46	87								
Crisps, nuts and snacks	153			152	99	1	1						
Sweet & savoury biscuits <sup>†</sup>	81	3	4	75	93					4	5		
Pies, pastries and cakes	17			12	71	1	6	1	6	3	18		
Bread	126	69	55	55	44							2	2
Cereal and cereal products	147	107	73	38	26	2	1						
Dry Rice, pasta and noodles	69	2	3	67	97								
Fish & seafood (fresh, frozen & processed)	20	20	100										
Fresh meat (chilled & frozen) <sup>†</sup>	24	2	8	3	13			19	79	9	38		
Processed meat <sup>†</sup>	117	99	85	9	8	20	17	4	3	3	3	1	1
Cheese & cheese products	43	33	77	7	16	4	9						
Dairy Products <sup>†</sup>	203	53	26	62	31	9	4	93	46			9	4
Oils						1	100						
Fruit (fresh & dried)	17	1	6	7	41	6	35	3	18				
Vegetables (fresh and salads)	10	2	20	6	60	1	10	1	10				
Liquid beverages non-alcoholic	598	289	48	2	0	307	51						
Dried beverages tea and coffee	4			4	100								
Processed foods and meals, ambient moist	10	4	40	6	60								
Processed foods and meals, chilled	16	10	63			5	31	1	6				
Processed foods and meals, frozen <sup>†</sup>	174	95	55	79	45			1	1				
Processed foods and meals, dehydrated	147	128	87	17	12			2	1				

\* N represents the number of food items in each food group that had one or more of their plastic food contact layers identified.

<sup>†</sup> Some of the food items in these groups had more than one plastic contact layer identified hence the sum of individual polymers identified (n) is greater than the number of food items in this group (N). <http://mc.manuscriptcentral.com/tfac> Email: [fac@tandf.co.uk](mailto:fac@tandf.co.uk)

**Table 5. Source of information of contact layer identification for polymers used in the Irish Food Packaging Database**

<b>Source of information</b>	<b>Frequency</b>	<b>Percent</b>
Polymer Development Centre	289	11.8
Similar identified by Polymer Development Centre*	329	14.9
<i>Subtotal for Polymer Development Centre</i>	618	26.7
Food Manufacturer	687	30.5
Packaging	661	29.4
Packaging Manufacturer	299	13.5
<b>Total</b>	2265	100.0

\*Food packaging items entered into the IFPD were grouped (food packaging groups) to allow efficient sampling of food packaging types for analyses. Packaging samples that were not actually analysed by ATR-FTIR but whose contact layer could be identified based on visual inspection of the material by experts and on the basis of similar entries being identified by the polymer development centre were coded separately in the database (Similar identified by Polymer Development Centre).

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

For Peer Review Only