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Design and preparation of market baskets of EU commercial baby foods for the assessment of infant exposure to food chemicals and to their effects

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5 **1 Design and preparation of market baskets of EU commercial baby**
6 **2 foods for the assessment of infant exposure to food chemicals and to**
7 **3 their effects**
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60**1 Abstract:**

2 The assessment of acute and chronic dietary exposure to contaminants in baby foods is
3 needed to ensure healthy infant growth. Monthly EU market baskets of commercial baby
4 foods were designed for the first 9 months of life by the “babyfood“ study group of the
5 CASCADE Network of Excellence for the specific purpose of assessing exposure to
6 potentially toxic substances in infants fed with such foods. The present paper reports the
7 different steps that led to the preparation of monthly pooled samples of commercial baby
8 foods (“Infant formulae and follow-on formulae”, and ”Other baby foods”) that may
9 constitute the extreme case of the diet for an infant that would not be breast fed at all.
10 Several market baskets were generated for an “average EU infant” and for infants of 4
11 selected countries (Italy, Sweden, Spain and Slovakia), fed with either milk infant
12 formulae, soy infant formulae or hypoallergenic infant formulae and weaned (at the 5th
13 month) with commercial baby foods and beverages available on the EU market. Market
14 share data for 2007 for baby foods were used to design the baskets. Holding companies
15 and the name of all their products were identified. Monthly diets for EU infants were
16 elaborated in terms of food categories (e.g. infant cereals) of typologies of products (e.g.
17 infant cereals without gluten) and of a specific product. The number of baskets generated
18 was 30 for “Infant formulae and follow-on formulae” (including 62 products) and 13 for
19 ”Other baby foods” (including 35 products). These market baskets were designed to be
20 used for the determination of certain contaminants and nutrients in the diet of EU infants
21 and for the assessment of their effects on infant health.

22
23 **Keywords:** Market basket, baby foods, infant formulae, contaminants, EU

1 Introduction

Commercial food products specifically designed for infants (0-12 months) are available on the market in all EU countries. Their composition is regulated by two specific directives related to “infant formulae and follow-on formulae” (European Commission 2006a) and to “cereal-based foods and baby foods for infants and young children” (European Commission 2006b). In the present paper the terms “Infant formulae and follow-on formulae” and “Other baby foods” (including all others solid and liquid commercial products designed for infants) are used to refer to these two groups of products. According to the legislation, “Infant formulae” (sometimes called “starting formulae”) are used during the first months of life and satisfying by themselves the nutritional requirements of such infants until the introduction of appropriate complementary feeding”, whereas “follow-on formulae” are used by infants when appropriate complementary feeding is introduced” (European Commission 2006a).

The lifestyles changes encourage an increasing number of women to work while their children are young and parents have generally little time to prepare home-cooked foods for infants. This factor, together with manufacturer’s innovation, probably contributed to the baby foods market growth which was observed in recent years (Research and Market 2006 [internet]). No more than 35% of infants worldwide are exclusively breastfed during the first four months of life (WHO 2003).

Therefore, in order to assess dietary exposure to potentially toxic substances in infants, it appears crucial to monitor their exposure through “Infant formulae and follow-on formulae” and “Other baby foods”.

Infants are especially vulnerable to the acute, sub-acute and chronic effects of ingestion of chemical hazards. The nervous, reproductive, digestive, respiratory and immune systems of infants are developing.

Moreover, dietary exposure of infants to chemical hazards tends to be higher than that of other population groups. In fact, the average energy requirement of an infant aged 0 to 9 months ranges from 0.40 to 0.48 MJ /kg body weight i.e. three times that of a sedentary adult aged 30-59 years which is 0.14 MJ/kg bw in males (10.7 MJ for 75 kg) and 0.13 MJ/kg bw in females (8.3 MJ for 62 kg) (Commission of the European Communities 1993). Therefore, when the concentration of a chemical is similar in the diet of infants and adults, the dietary exposure of infants is three times that of adults.

In the EU legislation on “Infant formulae and follow-on formulae” and “Other baby foods” there are specific provisions about hygiene, use of food additives, presence of some contaminants and on the use of materials intended to come into contact with foods. These

1 provisions are aimed to reduce the potential dietary exposure of infants to a number of
2 microbiological and chemical hazards.

3 However there are no provisions in relation to a number of important endocrine disruptors
4 (with the exception of provisions for pesticides).

5 Within the frame of the EU funded project CASCADE (“Chemicals as contaminants in
6 the food chain”; project website: www.cascadenet.org) a specific integrated study called
7 “Babyfood” was performed. The main objective of this study was to provide information on
8 dietary exposure through baby foods to a limited number of endocrine disruptors in the EU. The
9 target substances were bisphenol A (BPA), vinclozolin, polychlorinated dibenzo-p-dioxins and
10 dibenzofurans (PCDD/F), polychlorinated biphenyls (PCB), genistein, procimidone, iprodione
11 and cadmium.

12 The technique recommended by WHO (GEMS/Food 2005 [internet]) to assess dietary
13 exposure to contaminants is the analytical determination of market baskets; this technique is
14 very often used. The extreme case of an infant diet with the exclusive consumption of
15 commercial products is not desirable since breast milk is the preferred food for infants.
16 However, it provides a worst case for the assessment of potential exposure of children to food
17 chemicals contained in these products.

18 The aim of the present paper is to illustrate the methods used within the CASCADE
19 project for the preparation of market baskets of commercial baby foods representing the average
20 diet of infants (aged 0- 9 months) who are not breast fed at all and are fed with commercial baby
21 foods only.

22 **Materials and Methods**

23 ***Market basket design and sample collection***

24 In order to sample the food products, EU market baskets were created to represent the diet for
25 each of the first 9 months of life of an infant who is not breast fed at all and is fed with
26 commercial baby foods only. Such baskets, that aim to assess the average dietary exposure of
27 infants in the EU, may not capture information on the variability of such exposure. Therefore,
28 additional National market baskets were designed in order to assess the geographical variability.
29 Four countries were selected: Sweden, Italy, Spain and Slovak Republic.

30 To design the baskets, “Infant formulae and follow-on formulae” and “Other baby foods”
31 products were considered separately and monthly-based diets were elaborated. In the first group
32 of products “Infant formulae” and “follow-on formulae” were considered. Both typologies were
33 represented with three kinds of “Infant formulae and follow-on formulae”: milk based formula,
34 soy based formula and hypoallergenic formula, for a total of 6 kinds of products. The baskets
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5 1 simulate the progressive introduction in the diet of “Other baby foods” from 5 months of age of
6 2 an average infant weaned with commercial baby foods only. In the EU, some infants already
7 3 receive little quantities of complementary foods at 4 months but the majority of infants receive
8 4 such foods after 6 months of age, as suggested by World Health Organization (Michaelsen K et
9 5 al. 2003). Moreover a recent opinion by EFSA (2009) states that the introduction of
10 6 complementary food into the diet of healthy term infants in the EU between the age of 4 and 6
11 7 months is safe and does not pose a risk for adverse health effects. Month 5 was therefore
12 8 chosen to represent the average between fourth and sixth month. From month 5 to month 9 the
13 9 baskets of “Other baby foods” were varied every month with the addition of new “Other baby
14 10 foods” products.

11 11 Market share data of year 2007 of 22 single countries, for “Infant formulae and follow-on
12 12 formulae” and “Other baby foods”, were purchased from the Company "Food for Thought"
13 13 (FFT) ([Internet]). For each block of products taken separately, the overall market share of each
14 14 Holding Company in the 22 countries was taken to represent its market share for these products
15 15 in the whole EU. For the 4 specific countries, the national market share was used. These data
16 16 were used to identify the brands of the products to be sampled. The name of the Holding
17 17 Companies and of their main brands in 22 EU countries was obtained together with their overall
18 18 market share.

19 19 The company FFT was able to provide data for three blocks of products:

- 20 20 - *Baby milks*: including the 6 categories of baby milks to be sampled (“infant formulae” and
21 21 “follow-on” of milk formula, soy formula and hypoallergenic formula respectively).
22 22 - *Baby Jars* including: baby food canned, in bottles or in jars, excluding freeze dried products.
23 23 - *Other Baby Foods* including: juices and all dried products such as cereal powders with and
24 24 without milk, biscuits, dry pasta and any freeze-dried product such as freeze dried meat,
25 25 freeze dried fish, herbal tea.

26 26 The overall market shares for each of these three blocks of products were used as proxy
27 27 for the specific market shares of the specific products belonging to them.

28 28 Products belonging to the last two blocks, “Baby Jars” and “Other Baby Foods” are called
29 29 in this paper “Other baby foods”. They include all liquid and solid commercial baby foods with
30 30 the exclusion of “Infant formulae and follow-on formulae”.

31 31 To identify the products and to design the market baskets, different methods have been
32 32 followed depending on the category of products (“Infant formulae and follow-on formulae” or
33 33 “Other baby foods”) and the typology of the sample (EU or National).

34 34 Holding Companies were ranked in decreasing order of market shares and the first
35 35 companies that cumulatively reached over 80% were selected. These companies are called

1 hereafter “leading companies”. A check of the websites of these companies showed that they
2 produce and distribute the same (or similar) products in most EU countries. For logistic reasons,
3 the collection of products was therefore tentatively organised in a unique country. Germany was
4 selected. Consequently, the brands of the leading companies that were on the German market
5 were identified. In all cases where a leading company did not have a brand in Germany, an
6 alternative country was selected in which a brand of the same leading company was present.
7 Therefore only a part of products were bought in Germany. The criterion used for the selection
8 of the alternative country was “being the country with the highest estimated number of potential
9 consumers within EU”. Demographic data were downloaded from EUROSTAT (2009)
10 ([Internet]) to assess the dimension of the population aged less than 1 year in each of the 22 EU
11 countries. The number of potential consumers was estimated by weighing these data with the
12 market shares of the leading company of interest in each of the 22 countries.

13
14 Regarding the National baskets, in order to capture the highest variability in chemical
15 content of the diet, only one brand was identified in each of the four selected countries. It was
16 the main brand from the leading company with the highest market share in that country. If
17 certain categories of product were not produced by this leading company in that particular
18 country, the most popular product (from another Company) sold in the same category was
19 identified. This identification was performed through expert judgement.

20 21 “Infant formulae and follow-on formulae” baskets

22 In order to find the name of all “Infant formulae and follow-on formulae” products of the brands
23 identified, the websites of the brands were searched or the leading companies were contacted.

24 In term to EU baskets of “Infant formulae and follow-on formulae” the percentage of
25 each product was simply the proportion of market share of each brand among the leading
26 companies. In the event that more than one product was available for one brand, the market
27 share of the specific brand was equally divided by the number of products.

28 For the National baskets, each typology of product was represented by a unique brand in
29 each of the 4 selected countries and 100 was the percentage of each brand.

30 31 “Other baby foods” baskets

32 The name of the “Other baby foods” products were identified with the help of some CASCADE
33 partners who searched products on their own country market. In order to find the names of the
34 products to be sampled they were suggested to contact a Chemist’s who would provide them a
35 list of all products for the brand of interest or to search the websites of the companies or to

1 contact the companies. An appropriate database, organised by typology of products was filled
2 by CASCADE partners. The original name of each product and its English translation were
3 recorded together with a brief description of the product and some other information (typology
4 of packaging, month of introduction as suggested by the producer, main ingredients, ready to eat
5 or powder).

6
7 The following steps were followed to generate the baskets:

8 A) *Identification and assessment of the elements necessary for the elaboration of the diet for EU*
9 *and National infants from month 5 to month 9:*

- 10 • *Calculation of energy requirements:* the standard values of weight for age and sex
11 established by WHO (WHO 2006) and the estimated energy requirements (kcal/kg of
12 body weight/day) set by FAO (FAO 2004) for formula-fed infants were used to
13 calculate the average energy requirements (kcal/day) of infants in the first 9 months of
14 life (Table 1). For the reasons above explained, month 5 was chosen to insert little
15 quantities of complementary foods. It was observed that the average energy intakes
16 assessed by SCF (2003) from the 5th to the 7th months of age for infants fed with both
17 complementary foods and follow-on formula were slightly higher than the energy
18 requirements calculated from FAO (2004) and WHO (2006) (Table 1). Also average
19 body weights were slightly higher. Therefore, in table 1, for infants of 5th months of
20 age, the energy requirement for 5-6 month (622 kcal/day) was considered instead of that
21 for 4-5 month (598 kcal/day). The same substitution was also applied for months 6th to
22 9th.

23 (Table 1 here)

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25 • *Identification of food categories included in the “Other baby foods” basket for each*
26 *month of age:* in order to establish the month of inclusion of each category of product,
27 the guidelines for infant feeding developed by WHO Europe (Michaelsen K et al. 2003)
28 were considered. However, these guidelines do not provide recommendations at a high
29 level of detail in terms of product categories. The only paediatricians’ guidelines
30 providing recommendations at a high level of detail in the European region are those
31 from Switzerland. Therefore, the guidelines of the Swiss Paediatric Society (Société
32 Suisse de Pédiatrie 2002 [Internet]) were used to complement the WHO guidelines.
33 On these bases, a first theoretical schedule of the monthly inclusion of “Other baby
34 foods” was created. The availability of these products in the EU countries was then
35 investigated in order to produce a refined schedule (Figure 1). Thus, in the final

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5 1 schedule, used in the design of the market baskets, the food category “infant cereals”
6 2 was divided into “infant cereals without gluten”, “infant cereals with gluten” and
7 3 “infant cereals with milk” and the food category “fruit” was split into “pureed fruit” and
8 4 “fruit juice”. Eggs were not present in commercial baby foods for infants aged up to 9
9 5 months and therefore not considered in the final schedule. This is due to the caution
10 6 required in the introduction of whole eggs due to the allergy risk (Michaelsen et al.
11 7 2003). Moreover several brands of baby foods were found to distribute “dairy based
12 8 dessert with chocolate” that can be consumed by infants aged 6 to 9 months. The results
13 9 of the food consumption survey performed in UK (Mills et al. 1992) suggest that these
14 10 typologies of baby foods are effectively consumed in this period of the life. These
15 11 products were therefore also included in the 9th month basket and the food category
16 12 “dairy based dessert” was divided into “dairy based dessert with fruit” and “dairy based
17 13 dessert with chocolate”.

14 (Figure 1 here)

15
16 B) *Elaboration of the monthly diets:*

17 *Amounts, energy and nutrient content of “follow-on formulae” and “Other baby*
18 *foods”:* the estimated average amount of “follow-on formulae” consumed by
19 infants during the 5th, 6th and 7th month (respectively 600 ml/day, 400 ml/day and
20 240 ml /day) were taken from a report of Scientific Committee on Food (SCF
21 2003). These amounts of liquid “follow-on formulae” (ml/day) were translated in
22 gram/day of powder, according to the label of the sampled products, that suggests
23 to use on average 30 ml of water to dilute 4.6 g of powder of “follow-on formulae”
24 and based on an estimated volumetric density of milk of 1.03 g/ml (Di Thomas,
25 2003). The daily energy intake from “follow-on formulae” was calculated based on
26 its average energy content according to the labels of the products of 8 brands (70.8
27 kcal/100 g). The daily energy intake from “Other baby foods” was then calculated
28 by difference (Table 1).

29
30 To calculate the nutrient content of the elaborated diets, the average of values (by
31 typologies of product) reported on labels of 6 brands among the most popular in
32 EU was assessed.

33 *The monthly diets were elaborated in three steps:*

34 1) *in terms of main food categories (as infant cereals, pasta, fruits, meat etc...):* the
35 diets were designed in grams for each category of “Other baby foods”, based on

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4 1 the portion sizes suggested by producer labelling and on the meal daily frequency
5 suggested by WHO Europe (Michaelsen et al. 2003), with the exception of
6 “*infant cereals*” products. The amount of this latter category was calculated by
7 difference from the total calculated energy intake from “Other baby foods” (Table
8 1).
9

10 2) *in terms of typologies of foods products on the basis of specific features of the*
11 *products (as Infant cereals without milk and with gluten, Infant cereals with milk,*
12 *Pureed fruit, Fruit juice, Pulses with vegetables, Fish with vegetables etc...):* the
13 typologies of “Other baby foods” products to be included in the diets were chosen
14 based on prepared by the CASCADE partner database. Table 2 shows the
15 typologies of products and the specific features selected for inclusion in the EU
16 baskets.
17

18 The selection was based on the availability of similar products in different EU
19 countries. Added fats (oil, butter, etc....) were not sampled, since they were
20 present as ingredients in the mixed baby dishes and no such products specifically
21 designed for babies were available in any EU country.
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23 Table 3 shows the elaborated monthly diets infants from 5 to 9 months of age (in
24 terms of main category and typology of food products).
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26 For the National baskets of the 4 selected countries, the same typologies of
27 products were chosen. If some typologies of products were not available in
28 certain countries, the basket was modified for this country only. For example the
29 typologies of products “Infant cereals without milk and with gluten”, “Dairy
30 based dessert with chocolate”, “Biscuits”, “Pulses with vegetables and fish” and
31 “Pulses with vegetables and potatoes” were not available in Sweden. These
32 typologies were therefore replaced with “Infant cereals with milk and with
33 gluten” , “Dairy based dessert with forest fruit”, “Infant cereals with milk and
34 with gluten” and “Fish, pulses with vegetables and potatoes”, respectively. For
35 similar reasons the National baskets of Slovakia were slightly modified with
36 respect to the standard baskets.
37

38 (Tables 2 and Table 3 here)
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40 3) *in terms of specific products identified:* the tables filled in by the responsible
41 person for shopping were used to choose the specific products to be inserted in
42 the EU and National baskets, based on their ingredients.
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5 1 For each food typology, the products chosen were the same for all ages of the
6 2 infants; thus pureed fruit was the same at 5th, 6th, 7th, 8th and 9th. The National
7 3 baskets were designed with a unique product from a unique brand.
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10 5 The percentages of energy from proteins and lipids were calculated for the
11 6 monthly diet elaborated and compared with the WHO recommendations
12 7 (Michaelsen et al. 2003) for infants aged 5-9 months: 14-14.5 g/day of protein
13 8 and 30-40% of energy from lipids.
14 9

15 10 C) *Creation of the EU and National baskets:*

16 11 *Calculation of the percentage of the different products within the sample:* the
17 12 percentage of each brand within the EU and National baskets of “Other baby foods”
18 13 was simply the proportion of market share of each of the selected leading company
19 14 that were found to produce a specific product.

20 15 With regard to the EU basket, when a typology of product was not available for a
21 16 certain brand, “0” was assigned as percentage of market share for that leading
22 17 company and the percentage of the other brands of the same typology were
23 18 increased proportionally, leading to a “corrected market share” . As far as the
24 19 National baskets were concerned, also in this case, when the selected “leading
25 20 company” did not distribute a certain category of product in the country, the most
26 21 popular product of that category sold in the country was identified for sampling.
27 22

28 23 The preparation of the “Other baby foods” baskets, as they were designed initially and above
29 24 described, would have required collection and sample preparation of a huge number of products
30 25 and consequently lead to very high costs in terms of time and budget resources. Therefore, a
31 26 random sampling of brands, weighed on market share, was performed in order to identify only
32 27 one brand within each typology of product. For the National baskets of “Other baby foods”,
33 28 only the 5th month diet was prepared due to lower number products included compared with
34 29 month 6th, 7th, 8th and 9th.

35 30 Table 4 shows an example of EU basket of “Infant formulae and follow-on formulae” and
36 31 “Other baby foods” at month 5 with the products purchased only (the name of the brands were
37 32 substituted with a code). The other baskets (with all the products selected and with the products
38 33 purchased only) are not reported as tables in the present paper due to space restrictions but can
39 34 be requested to the corresponding author.

40 35 (Table 4 here)

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6 2 D) *Purchase of the products to be sampled*

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8 3 More than half of the products needed to constitute the EU baskets had to be bought in EU
9 4 countries other than Germany by the CASCADE partners (57% of “Infant formulae and
10 5 follow-on formulae” and 55% of “Other baby foods” products) and delivered to Helmholtz
11 6 Zentrum München. The other products were bought in Germany, where sample preparations
12 7 were performed prior analyses.
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17 9 *Pooling, homogenisation, and lyophilisation of the baby foods samples*

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19 10 The pooling of the EU and National basket baby foods samples and related weighting
20 11 procedures were performed in a purified glovebox under nitrogen atmosphere. Prior to pooling,
21 12 the solid food and beverages were lyophilised using the freeze drying equipment Type BETA
22 13 1-16 (Christ GmbH). Overall, the duration of the procedure for each food item was about 36
23 14 hours. After lyophilisation, the weight of baby food products was reduced with yield varying
24 15 from 12 to 22%. The proportion of each “Other baby foods” product in the pooled samples was
25 16 that reported in Table 4. The samples were homogenised in a rotoshaker, Type Reax 20/8
26 17 (Heidolph GmbH) for 8 hours at 10 rpm.
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32 18 The samples were kept at room temperature and stored in brown glass jars protected from
33 19 direct light. In order to prevent any contamination, each further open and close of the sample
34 20 collector was performed under nitrogen atmosphere.
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39 22 **Results**

40 23 The number of baskets and of product sampled is reported in Table 5.
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44 25 *“Infant formulae and follow-on formulae” baskets*

45 26 The first 8 leading companies of “Infant formulae and follow-on formulae” in the EU were
46 27 selected, covering altogether 82% of the entire EU market. A total of 42 products were
47 28 purchased from 6 different countries in order to prepare 6 EU market baskets of “Infant
48 29 formulae and follow-on formulae”.
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51 30 On the other hand, 20 products were purchased to prepare 24 National market baskets of
52 31 “Infant formulae and follow-on formulae”.
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56 32
57 33 *Other baby foods baskets*

58 34 With regard to the baskets of “Other baby foods”, the 6 leading companies of the “baby jars”
59 35 market and the first 7 companies of the “other baby foods” market were selected, covering
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1 altogether respectively 82% and 81% of the entire EU market. Nine EU market baskets of
2 “Other baby foods” were designed and 112 products were identified. However because of the
3 above mentioned reasons, only 22 randomly extracted products were sampled from 5 different
4 countries.

5 As far as National baskets of “Other baby foods” are considered, 4 market baskets were
6 elaborated and 47 products were identified. As already mentioned only the basket for the 5th
7 months was prepared, based on a total of 13 products.
8 (Table 5 here)

11 **Discussion and conclusion**

12 Robust estimates of consumer exposure to food chemicals are needed for regulatory chemical
13 risk assessment. Among the main approaches to food chemical intake assessment, WHO
14 recommends the development of a diet model or market basket representing the average diet of
15 the considered population. This model may then be analysed directly for food chemicals of
16 interest (WHO 1999).

17 Survey market baskets are generally developed on the basis of national food
18 consumption data. It is the case in the U.S (FDA[Internet]), in Australia (FSANZ [Internet]),
19 and in the UK (MAFF [Internet]). A food consumption survey that could be considered
20 representative at EU level is not available. Moreover, in many EU countries, information on
21 exposure to chemical hazards in the diet is collected for the whole population, not specifically
22 for children or infants. The available information is often incomplete or not comparable between
23 EU countries. In order to assess exposure to hazardous chemicals through food, the data
24 collection needs to be harmonized and data need to be collected regularly and to reflect the
25 specific risks to children and infants in the region (ENHIS 2007). For these reasons the
26 methodologies generally used to elaborate national markets baskets have been adapted to the
27 needs of this study. Baskets were designed on the basis of theoretical schemes of insertion of
28 baby foods and of EU market share data for “Infant formulae and follow-on formulae” and
29 “Other baby foods”.

30 The market share data purchased were expressed in value (money) because baby food
31 data expressed in volume (amount of products) were not available at the same level of
32 disaggregation. Although the price of products of the same typology can be different depending
33 on the brand, one leading company can also produce more than one brand destined to different
34 kinds of market (e.g. only for supermarkets with a low or medium price, only for chemists’ with
35 a high price). It was therefore assumed that on average the prices of similar products are

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5 1 comparable among the companies and data purchased were used as a proxy for market shares in
6 2 volumes.

7 3 Another limitation of the market basket illustrated in the present paper is that the market
8 4 shares of the specific categories of “baby milks”, “baby jars” and “other baby foods” were not
9 5 available. Thus, since no specific market shares were available for “fruit baby jars” the
10 6 assumption was made that the market shares of “baby jars” in general could apply to “fruit baby
11 7 jars”. Moreover, market share data used to identify the brands of the products to be sampled, did
12 8 not contain private brands (supermarket) and baby foods of this kind of market were not
13 9 sampled. However, the market share of each of these private brands is known to be low and they
14 10 would not have been selected as leading brands. In fact, the overall market share of non
15 11 identified brands of all the baby foods categories considered was 4.5% including private labels.
16 12 Since the overall share of such private brands is growing, in future studies one might consider
17 13 the random extraction of some private brands that would be included in the market basket in
18 14 proportion to such overall share.

19 15 The amount of proteins in the monthly diets here elaborated and expressed in terms of
20 16 typologies of products was higher than recommended by WHO (up to 11% versus 9%) (Table
21 17 4). However, this percentage of protein is lower than that observed in food consumption surveys
22 18 performed in infants in some European countries: 13.2% of energy in the UK for infants aged 6-
23 19 9 months (Mills et al 1992), 11.2-13.2% of energy in Germany for infants aged 3-9 months
24 20 (Alexy et al. 1999), 13-14% of energy in Denmark for infants aged 9^h months (Hoppe et al.
25 21 2004), 13.3-15.7% of energy in Spain for infants aged 4-9 months (Capdevila et al. 1998). The
26 22 amount of proteins in the diets considered in the present paper are therefore intermediate
27 23 between that recommended by WHO and that observed in consumption surveys.

28 24 On the other hand, the percentage of energy from fat was slightly lower than
29 25 recommended (24-35% versus 30-40%), due to the fact that ‘added fats’ were not considered in
30 26 the elaboration of the monthly diets.

31 27 It is likely that some infants can consume honey since birth. This fact was taken in
32 28 consideration, but this food was not sampled because honey is not distributed by companies of
33 29 baby foods.

34 30 The lyophilisation of fruity baby foods in jar result a sticky material that caused
35 31 difficulties in further homogenisation of the samples. As a consequence, these specific products
36 32 were delivered separately from the other products belonging to the same basket. The further
37 33 pooling was therefore performed in each testing laboratory itself according above mentioned
38 34 weighting procedures.

1 During the survey, the labels of infant formulae were checked and it appeared that the
2 total energy intake of infants aged 0-4 months could be higher than recommended when the
3 consumer followed instructions reported on the label. This observation has been reported by
4 Pandelova et al., (2009a).

5 Several samples of “Infant formulae and follow-on formulae” and “Other baby foods”,
6 both extracted and non extracted, were prepared and delivered to CASCADE partners for
7 further chemical target analysis, *in-vitro* and *in-vivo* testing. The results of some analyses are
8 published (Riu 2008, Pandelova 2009b).

9 The above described samples of baby foods have been used for the assessment of dietary
10 exposure to a number of substances within the CASCADE project, with the aim of obtaining a
11 realistic panorama of exposure to food chemicals in the infant population, useful for quantitative
12 risk assessment.

13 Market basket studies involve the analysis of groups of foods that reflect the average
14 food consumption patterns of a given population. They may be used to establish specific
15 maximum limits when there is evidence that the health of specific consumers may be at stake
16 (CGSCTFF, 1999). In the present study, a market basket was designed to assess exposure in a
17 very sensible population group: infants.

18 Given the time and resources available it was decided to distinguish only two groups of
19 foods: “infant formulae and follow-on formulae” and “other products” and to focus on possible
20 variability at the different ages of the babies and between countries rather than on variability
21 between products categories. Thus, if a food chemical was to be found at a high level of
22 concentration in one or more of the designed baskets it may not be possible to identify the
23 incriminated product category. However, products were purchased in excess so that further
24 analyses on single categories can be performed afterwards.

25 Despite some limitations, the method should allow to assess average dietary exposure of
26 infants in the EU. The food items considered for the elaboration of the monthly diets are those
27 normally consumed by this population group, the quantities were set based on nutritional
28 requirements of infants and the products were purchased in seven different EU countries on the
29 basis of EU market share data collected in 22 countries. The technique could be used again in
30 the future and the exposure data obtained through this methodology could support regulatory
31 actions over time and contribute to the promotion of health of infants fed with commercial foods
32 during early development.

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FOOD CATEGORIES	MONTHS								
	1	2	3	4	5	6	7	8	9
INFANT FORMULAE FOLLOW-ON					■	■	■	■	■
INFANT CEREALS:									
<i>INFANT CEREALS without gluten</i>					■	■	■	■	■
<i>INFANT CEREALS with gluten</i>						■	■	■	■
<i>INFANT CEREALS with milk</i>						■	■	■	■
PASTA							■	■	■
BISCUITS								■	■
FRUIT:									
<i>PUREED FRUIT</i>					■	■	■	■	■
<i>FRUIT JUICE</i>						■	■	■	■
VEGETABLES/POTATOES					■	■	■	■	■
PULSES						■	■	■	■
MEAT					■	■	■	■	■
FISH								■	■
DAIRY BASED DESSERT:									
<i>DAIRY BASED DESSERT with fruit</i>							■	■	■
<i>DAIRY BASED DESSERT with chocolate</i>									■
ADDED FATS (OIL/BUTTER etc...)					■	■	■	■	■

Figure 1. Time of inclusion of baby food categories: final schedule used in the design of the CASCADE market baskets of “Other baby foods”.

Table 1. Calculated average energy requirement (kcal/day) by age class in infants aged 0 to 10 months, SCF data from 5th to 9th month and calculated daily energy intake from “Infant formulae and follow-on formulae” (follow-on) and “Other baby foods”

Months	Calculated average body weight ⁽¹⁾ at 50 th percentile (kg)	Energy requirement in formula-fed infants (kcal/kg bw/day) ⁽²⁾	Calculated average energy requirement (kcal/day) ⁽³⁾	SCF ⁽⁴⁾ energy intake for infants fed with both complementary foods and follow-on formula (kcal/day)	Amount (ml/day) of infant formulae (follow-on) ⁽⁴⁾	Energy intake from “infant formulae” (follow-on) ⁽⁵⁾ (kcal/day)	Energy intake from “Other baby foods” ⁽⁶⁾ (kcal/day)
0–1	3.80	120	456				
1–2	4.85	109	529				
2–3	5.73	100	573				
3–4	6.40	87	557				
4–5	6.95	86	598				
5–6	7.40	84	622	650-690	600	425	197
6–7	7.78	81	630	650-730	400	283	347
7–8	8.10	81	656	768-816	240	170	486
8–9	8.40	81	680		240	170	510
9–10	8.70	81	705		240	170	535

(1) Average body weight in infants of age between month x and month x+1 was estimated by calculating 1) the average of 50th percentile at month x and month x+1 in both females and males, according to WHO 2006 and 2) by calculating the average between the values obtained in females and males.

(2) FAO 2004.

(3) For infants of 5 months of age, calculated average energy requirement for 5-6 month (622 kcal/day) was used instead of that for 4-5 month (598 kcal/day). The same was performed for 6th to 9th months of age.

(4) SCF 2003.

(5) Energy intake from infant formulae was calculated multiplying the average of the energy content reported on the labels of sampled products (on average, 100 g of rehydrated infant formulae follow-on contain 71 kcal) by the amount of infant formula (ml/day) consumed by infants during the 5h, 6th and 7h month (SCF 2003); the amount of infant formulae follow-on consumed at 8th and 9th month is assumed to be the same as that consumed at 7th month (one baby bottle).

(6) Energy intake from “Other baby foods” were calculated by subtracting the energy intake deriving from “Infant formulae” from the calculated average energy requirements

Table 2. Categories and typologies of baby foods chosen to design baskets from 5th and 9th month.

FOOD CATEGORY	TYOLOGY OF FOOD PRODUCTS	SPECIFIC FEATURES OF THE TYPOLOGIES OF PRODUCTS
INFANT FORMULAE AND FOLLOW-ON FORMULAE	Infant formula follow-on	Infant formula follow on - in powder
INFANT CEREALS:		
	Infant cereals without milk and without gluten	Rice - in powder
	Infant cereals without milk and with gluten	Multicereals or cereals with gluten- in powder
	Infant cereals with milk	Infant cereals with milk and fruit or honey - in powder
PASTA	Rice or pasta with meat and vegetables	Rice or pasta (around 20%) with meat (veal and/or chicken and/or turkey) (around 20%) and vegetables (around 60%) - where available with potatoes - in jars (ready to eat)
BISCUITS	Infant biscuits	Biscuits with gluten - No granular
FRUIT:		
	Pureed fruit	Fruit mix with two fruit among apple and/or pear and/or banana and/or apricot- in jars (ready to eat)
	Fruit juice	Apricot or other if not available - liquid (ready to eat)
PULSES/VEGETABLES	Pulses with vegetables	Pulses (around 40%) and vegetables (around 60%) - where available with potatoes - in jars (ready to eat)
FISH	Fish with vegetables	Fish (sole and/or salmon and/or codfish) (around 40%) with vegetables (around 60%) - where available with potatoes- in jars (ready to eat)
MEAT	Meat with vegetables	Meat (veal and/or chicken and/or turkey) (around 40%) with vegetables (around 60%) - where available with potatoes - in jars (ready to eat)
DAIRY BASED DESSERT	Dairy based dessert	Milk or cheese based dessert with forest fruit or chocolate - in jars (ready to eat)

Table 3. Theoretical diets elaborated in terms of main food categories and of typologies of commercial baby foods (months 5-9).

DIET IN TERMS OF MAIN FOOD CATEGORIES			DIET IN TERMS OF TYPOLOGIES OF FOOD PRODUCTS		
CATEGORIES	Daily consumption (g/day) ⁽¹⁾	Energy (kcal)	TYPOLOGIES	Daily consumption (g/day)	Energy (kcal)
5th MONTH					
Infant formulae and follow-on formulae	89 (600) ⁽²⁾	425	Infant formulae follow-on (powder)	89 (600) ⁽²⁾	425
Infant cereals ⁽³⁾	12	44	Infant cereals without milk and without gluten (powder)	20	74
Fruit	80	59	Pureed fruit (jar)	80	59
Vegetables	40	19	Meat ⁽⁵⁾ +vegetables +potatoes (jar)	100	63
Meat	40	33			
Added fats (oil/butter etc.) ⁽⁴⁾	5	41			
Total		622	Total		622
6th MONTH					
Infant formulae and follow-on formulae	60 (400) ⁽²⁾	283	Infant formulae follow-on (powder)	60(400) ⁽²⁾	283
Infant cereals ⁽³⁾	33	126	Infant cereals without milk and without gluten (powder)	15	57
			Infant cereals without milk and with gluten (powder)	15	56
Fruit	100	74	Pureed fruit (jar)	75	56
			Fruit juice (liquid)	25	14
Vegetables/ Pulses	80	39	Meat ⁽⁵⁾ +vegetables +potatoes (jar)	200	126
Meat	80	65			
Added fats (oil/butter etc.) ⁽⁴⁾	5	41			
Total		630	Total		630

(1) The theoretical diets were designed in order to ensure that the energy intake from “Infant formulae and follow-on formulae” and from “Other baby foods” were in line with those reported in table 2.

(2) In parenthesis consumption of ”Infant formulae” expressed in ml/day of product ready to be consumed.

(3) The amount of this food category was calculated by difference from the calculated energy intake from ”Other baby foods” (Table 3).

(4) “Added fats (oil/butter etc.)” were not sampled, since they are present in commercial baby foods mixed dishes and no such products specifically designed for babies were found to be available in any EU country.

(5) The total quantity of jars containing meat was calculated to ensure the daily consumption of the portion size of meat considered in the theoretical diets elaborated in terms of main food categories.

Table 3 (continued). Theoretical diets elaborated in terms of main food categories and of typologies of commercial baby foods (months 5-9).

DIET IN TERMS OF MAIN FOOD CATEGORIES			DIET IN TERMS OF TYPOLOGIES OF FOOD PRODUCTS		
CATEGORIES	Daily consumption (g/day) ⁽¹⁾	Energy (kcal)	TYPOLOGIES	Daily consumption (g/day)	Energy (kcal)
7th MONTH					
Infant formulae and follow-on formulae	36 (240) ⁽²⁾	170	Infant formulae follow- on (powder)	36 (240) ⁽²⁾	170
			Infant cereals without milk and without gluten (powder)	10	38
Infant cereals ⁽³⁾	27	101	Infant cereals without milk and with gluten (powder)	20	75
			Infant cereals with milk and fruit (powder)	10	36
Fruit	160	118	Pureed fruit (jar)	120	89
			Fruit juice (liquid)	40	22
Pasta	20	71	Pasta + meat +vegetables +potatoes (jar)	100	63
Vegetables/ Pulses	100	49	Pulses +vegetables +potatoes (jar)	75	38
Meat	80	65	Meat ⁽⁵⁾ +vegetables +potatoes (jar)	150	95
Dairy based dessert	40	40	Dairy based dessert (with fruit) (jar)	40	39
Added fats (oil/butter etc..) ⁽⁴⁾	5	41			
Total		656	Total		665
8th MONTH					
Infant formulae and follow-on formulae	36 (240) ⁽²⁾	170	Infant formulae follow- on (powder)	36 (240) ⁽²⁾	170
			Infant cereals without milk and without gluten (powder)	9	33
Infant cereal ⁽³⁾	26	99	Infant cereals without milk and with gluten (powder)	18	66
			Infant cereals with milk and fruit (powder)	9	32
Biscuits	8	33	Baby biscuits	8	33
Fruit	160	118	Pureed fruit (jar)	120	89
			Fruit juice (liquid)	40	22
Pasta	20	71	Pasta + meat +vegetables +potatoes (jar)	100	63
Vegetables/ Pulses	100	49	Pulses + vegetables + Potatoes (jar)	75	38

Meat	50	41	Meat ⁽⁵⁾ +vegetables +potatoes (jar)	75	47
Fish	30	18	Fish +vegetables +potatoes (jar)	75	49
Dairy based dessert	40	40	Dairy based dessert (with fruit) (jar)	40	39
Added fats (oil/butter etc..) ⁽⁴⁾	5	41			
Total		680	Total		681

- (1) The theoretical diets were designed in order to ensure that the energy intake from “Infant formulae and follow-on formulae” and from “Other baby foods” were in line with those reported in table 2.
- (2) In parenthesis consumption of ”Infant formulae” expressed in ml/day of product ready to be consumed.
- (3) The amount of this food category was calculated by difference from the calculated energy intake from ”Other baby foods” (Table 3).
- (4) “Added fats (oil/butter etc..)” were not sampled, since they are present in commercial baby foods mixed dishes and no such products specifically designed for babies were found to be available in any EU country.
- (5) The total quantity of jars containing meat was calculated to ensure the daily consumption of the portion size of meat considered in the theoretical diets elaborated in terms of main food categories.

Table 3 (continued). Theoretical diets elaborated in terms of main food categories and of typologies of commercial baby foods (months 5-9).

DIET IN TERMS OF MAIN FOOD CATEGORIES			DIET IN TERMS OF TYPOLOGIES OF FOOD PRODUCTS		
CATEGORIES	Daily consumption (g/day) ⁽¹⁾	Energy (kcal)	TYPES	Daily consumption (g/day)	Energy (kcal)
9 ^h MONTH					
Infant formulae and follow-on formulae	36 (240) ⁽²⁾	170	infant formulae follow-on (powder)	36 (240) ⁽²⁾	170
			Infant cereals without milk and without gluten (powder)	8	28
Infant cereals ⁽³⁾	22	83	Infant cereals without milk and with gluten (powder)	15	56
			Infant cereals with milk and fruit (powder)	8	27
Biscuits	8	33	Baby biscuits	8	33
Fruit	160	118	Pureed fruit (jar)	120	89
			Fruit juice (liquid)	40	22
Pasta	20	71	Pasta + meat +vegetables +potatoes (jar)	100	63
Vegetables/ Pulses	100	49	Pulses + vegetables + potatoes (jar)	75	38
Meat	50	41	Meat ⁽⁵⁾ +vegetables +potatoes (jar)	75	47
Fish	30	18	Fish +vegetables +potatoes (jar)	75	49
			Dairy based dessert (with fruit) (jar)	60	59
Dairy based dessert	80	80	Dairy based dessert (with chocolate) (jar)	20	20
Oil/butter ⁽⁴⁾	5	41			
Total		705	Total		701

(1) The theoretical diets were designed in order to ensure that the energy intake from “Infant formulae and follow-on formulae” and from “Other baby foods” were in line with those reported in table 2.

(2) In parenthesis consumption of ”Infant formulae” expressed in ml/day of product ready to be consumed.

(3) The amount of this food category was calculated by difference from the calculated energy intake from ”Other baby foods” (Table 3).

(4) “Added fats (oil/butter etc..)” were not sampled, since they are present in commercial baby foods mixed dishes and no such products specifically designed for babies were found to be available in any EU country.

(5) The total quantity of jars containing meat was calculated to ensure the daily consumption of the portion size of meat considered in the theoretical diets elaborated in terms of main food categories.

Table 4. EU basket of “Infant formulae and follow-on formulae” and “Other baby foods” at month 5, as sampled within the CASCADE project – with milk based infant formula follow-on.

Typology	DIET			MARKET BASKET								
	Grams	% Total diet	% “Other baby foods”	Sampling country	Sampled products	Description	Brand	Market share (%) ⁽¹⁾	Corrected market share (%) ⁽²⁾	Product by typology (%)	“Other baby foods” basket (%)	“Infant formulae” and “Other baby foods” basket (%)
Milk based infant formula follow on	89	68.3										
				Germany	Product 1		BRAND A	27.9	13.95	17.0		11.58
				Germany	Product 2		BRAND A		13.95	17.0		11.58
				Germany	Product 3		BRAND B	26.5	26.5	32.2		22.00
				UK	Product 4		BRAND D	9.3	9.3	11.3		7.72
				France	Product 5		BRAND F	5.9	5.9	7.2		4.90
				Sweden	Product 6		BRAND H	3.6	3.6	4.4		2.99
				Germany	Product 7		BRAND C	3.4	3.4	4.1		2.82
				France	Product 8		BRAND G	3	3	3.6		2.49
				Italy	Product 9		BRAND I_1	2.7	0.9	1.1		0.75
				Italy	Product 10		BRAND I_3		0.9	1.1		0.75
				Italy	Product 11		BRAND I_2		0.9	1.1		0.75
					Total			82.3	82.3	100.0		68.33
Infant cereals without gluten and without milk	20	11.9	37.7									
				France	Product 12	rice vanilla flavour	BRAND F			100.0	37.8	12.00
Pureed Fruit	80	9.6	30.2									
				Germany	Product 13	peaches and apple and apricots	BRAND B			50.0	15.1	4.78
				Germany	Product 14	fruit peaches, apricots, apple	BRAND B			50.0	15.1	4.78
					Total					100.0	30.2	9.56
Meat +vegetables +potatoes ⁽³⁾	100	10.2	32.1									
				Italy	Product 15	beef/chicken	BRAND I_1			16.7	5.3	1.69
				Italy	Product 16	beef/chicken	BRAND I_3			16.7	5.3	1.69
				Italy	Product 17	beef/chicken	BRAND I_2			16.7	5.3	1.69
				Italy	Product 18	mixed vegetables	BRAND I_1			50.0	16.0	5.08
					Total					100.0	32.9	10.15
		100	100									

(1) Data referred to 2007, purchased from the Company "Food for Thought" (FFT) (<http://www.fft.com/fft/servlet/fft/template/Index.vm>).

(2) In the event that more than one product was available for one brand, the percentage of each brand was equally divided by the number of products.

(3) Meat jars of the sampled company do not contain vegetables. As a consequence the typologies “meat + vegetables +potatoes” was obtained by combining meat jars and vegetables jars.

Table 5. Number of baskets created and of products purchased within the CASCADE project.

	Types of baskets	Typologies of infant formulae	Number of BASKETS created	Number of PRODUCTS purchased	Country where the products were purchased	
	"INFANT FORMULAE AND FOLLOW_ON FORMULAE"					
	Infant formulae (0-4 months)	Milk based	1			
		Soya based	1			
		Hypo Allergenic	1			
	Follow-on (after 4 th month)	Milk based	1			
		Soya based	1			
		Hypo Allergenic	1			
		TOTAL	6			
EU				18	Germany	
				4	UK	
				9	France	
				1	Portugal	
				3	Sweden	
				7	Italy	
				42	TOTAL	
		"OTHER BABY FOODS"		9		
					10	Germany
					9	Italy
				1	France	
				1	Spain	
				1	UK	
				22	TOTAL	
	"INFANT FORMULAE AND FOLLOW_ON FORMULAE"					
	Infant formulae (0-4 months)	Milk based	4			
		Soya based	4			
		Hypo Allergenic	4			
	Follow-on (after 4 th month)	Milk based	4			
		Soya based	4			
		Hypo Allergenic	4			
		TOTAL	24			
NATIONAL				6	Italy	
				5	Slovak Republic	
				5	Spain	
				4	Sweden	
				20	TOTAL	
		"OTHER BABY FOODS"		4		
					4	Italy
				3	Slovak Republic	
				3	Spain	
				3	Sweden	
				13	TOTAL	

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