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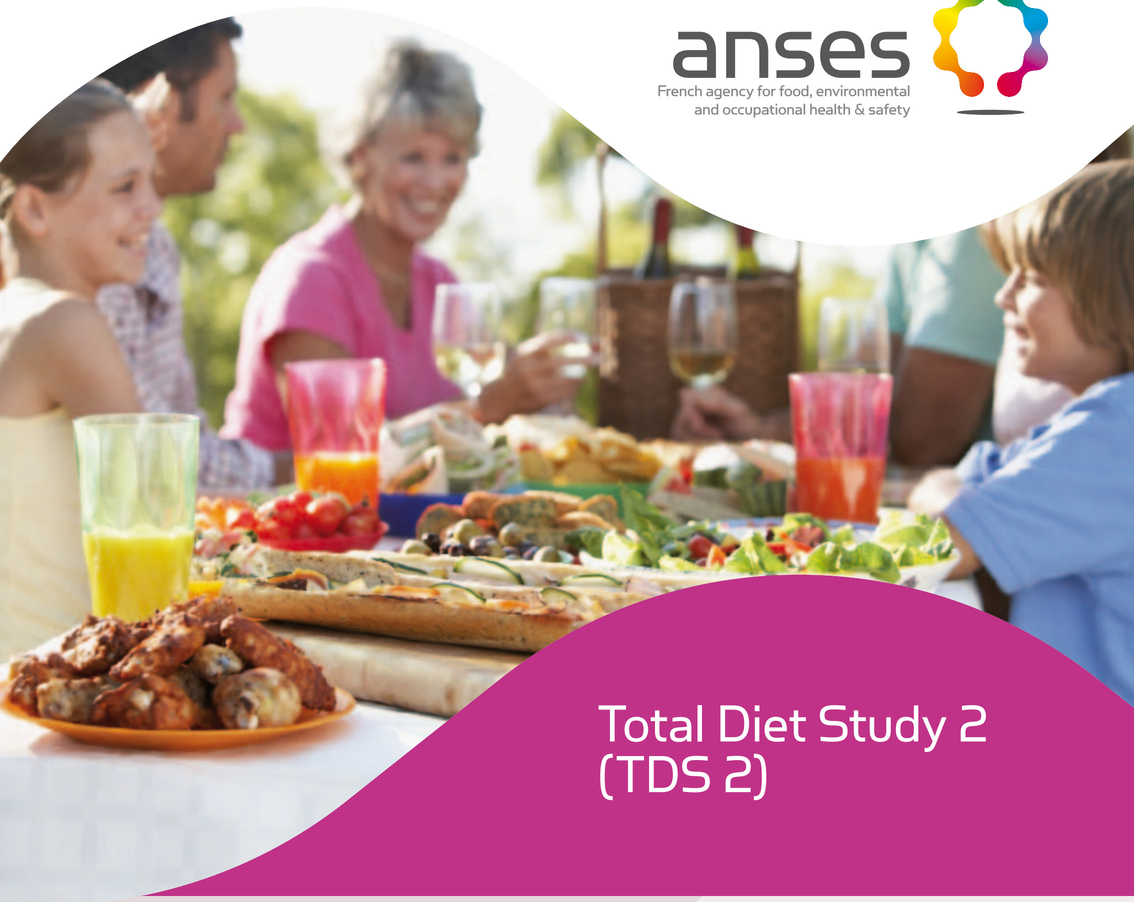

Total Diet Study 2 (TDS 2)

Opinion of the French Agency for Food, Environmental and Occupational Health & Safety

21 June 2011

ANSES undertakes independent and pluralistic scientific expert assessments. ANSES primarily ensures environmental, occupational and food safety and assesses potential health risks in these areas.

It also contributes to the protection of the health and well-being of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.

It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).

Its opinions are made public.

Background and subject of the request

Knowledge of potential food contamination and of the nutritional composition of foods is a major health tool. Indeed, it is used to document dietary exposure to microbiological, chemical and physical agents as well as nutritional intake. These exposure levels make it possible to assess risks to the population and thus make enlightened risk management decisions (monitoring and regulations) at the national, European and international levels. In France, food contamination is monitored on a regular basis in a regulatory framework through monitoring and surveillance plans that are managed by the competent ministries.

This knowledge can be supplemented and strengthened by Total Diet Studies (TDSs). These studies use a standardised method recommended by the World Health Organization (WHO). They aim to screen for various substances that are likely to be found in food 'as consumed'.

These substances may be found:

- because they are naturally present (this is true for inorganic contaminants, minerals, phytoestrogens) or are due to contamination of environmental origin, either natural (the case of mycotoxins) or due to industrial, agricultural, domestic human activities, etc. (case of persistent organic pollutants);
- because they are used for technological or agricultural reasons, or because they are formed during the production, transformation or preservation of the raw material or of food ready to be eaten (case of substances authorised under certain conditions such as food additives and plant protection products, or heat-induced contaminants).

In addition to characterising consumer exposure to contaminants found in food, these studies also assess, for certain minerals, consistency between intakes and the population's nutritional requirements. Lastly, they identify the foods that most contribute to intake and exposure.

ANSES Request no. 2006-SA-0361

A first French Total Diet Study (TDS 1) was undertaken between 2000 and 2004 by the French National Institute for Agricultural Research (INRA), in collaboration with the French Food Safety Agency (AFSSA). This led to a comprehensive appraisal of the population's exposure, including adults and children, to inorganic contaminants and minerals, as well as mycotoxins.

In 2006, the Agency issued an internal request in order to undertake a second study (TDS 2), which included 445 substances (see comprehensive list in Section 2) *versus* 30 in the first study. This new study was financed with public funds by the Ministries in charge of Food, Health and Consumer Affairs, with a contribution from the French Observatory for Pesticide Residues. A budget of nearly 5 million euros was thus allocated to perform all of the necessary samples and analyses.

All of the substances that had been analysed in TDS 1 were tested for in TDS 2 in order to determine trends by monitoring the population's exposure levels. Numerous other substances were added to this list in order to improve the description of exposure. This new study covered all of mainland France through eight inter-regions, while three major cities had been studied in TDS 1. It was based on the data from the French individual and national study on food consumption (INCA 2), which was undertaken in 2006-2007 and was representative of food consumption in France.

In the end, this study resulted in the collection of 20,000 food products representing 212 types of food (Annex 1), for which 445 substances of interest were investigated.

Organisation of the expert appraisal

All of the data produced during this study are presented in a scientific expert assessment report. This opinion summarises TDS 2's objectives, method and results, presents its main conclusions and formulates recommendations.

The objectives, study method, results and their interpretation were submitted for validation to various Expert Committees at the Agency ('Human nutrition', 'Physical and chemical contaminants and residues', 'Additives, flavourings and processing aids' and 'Plant protection products, chemical substances and preparations'). The selection of substances and health-based guidance values taken into account for the risk assessment and nutritional references was validated by the expert committees. The latter then analysed the results and formulated recommendations for follow-up action when necessary.

Regarding the choice of substances

The Agency's selection of substances of interest took into account various criteria: the importance of risk assessment for various substances, description of exposure trends over time. It was necessary to supplement the analytical data and the description of exposure for certain contaminants. This selection was also the result of a review of the literature in order to identify emerging substances for which risk assessment was relevant.

This selection also took into account available analytical possibilities: analytical techniques were developed for the study's needs when there were no standardised techniques. Lastly, the monitoring recommendations previously issued by the Agency were also taken into account. Regarding pesticides, 283 active plant protection substances were selected, in order to improve surveillance of the population's exposure to pesticides, one of the actions in the 2004-2008 French National Environment and Health Action Plan. This information will be added to the database of the French Observatory for Pesticide Residues.

Among the selected substances, 361 were the subject of regulations setting maximum limits in certain foodstuffs or in drinking water (Annex 3).

In the end, 445 substances were tested:

- 16 inorganic contaminants naturally found in the environment and sometimes resulting from human activities: aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), cadmium (Cd), cobalt (Co), gallium (Ga), germanium (Ge), lead (Pb), mercury (Hg), nickel (Ni), silver (Ag), strontium (Sr), tellurium (Te), tin (Sn), vanadium (V);
- 12 minerals: calcium (Ca), chromium (Cr), copper (Cu), iron (Fe), lithium (Li), magnesium (Mg), manganese (Mn), molybdenum (Mo), potassium (K), selenium (Se), sodium (Na), zinc (Zn);
- 17 congeners of polychlorodibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/F) resulting from human activities or naturally found in the environment: TCDD-2378, PCDD-12378, HCDD-123478, HCDD-123678, HCDD-123789, HCDD-1234678, OCDD, TCDF-2378, PCDF-12378, PCDF-23478, HCDF-123478, HCDF-123678, HCDF-234678, HCDF-123789, HCDF-1234678, HCDF-1234789, OCDF;
- 12 congeners of 'dioxin-like' polychlorinated biphenyls (DL-PCBs) resulting from human activities: PCB-77, 81, 126, 169, 105, 114, 118, 123, 156, 157, 167, 189;
- 6 congeners of 'non-dioxin-like' polychlorinated biphenyls (NDL-PCBs) resulting from human activities: PCB-28, 52, 101, 138, 153, 180;
- 16 perfluorinated compounds resulting from human activities: carboxylates (PFOA, PFBA, PFPA, PFHxA, PFHpA, PFNA, PFDA, PFUnA, PFDoA, PFTrDA, PFTeDA) and sulfonates (PFOS, PFBS, PFHxS, PFHpS, PFDS);
- 14 brominated flame retardant (BFR) compounds resulting from human activities: 8 polybrominated diphenyl ether congeners (BDE-28, 47, 99, 100, 153, 154, 183, 209), 3 polybrominated biphenyl congeners (BB-52, 101, 153), and 3 hexabromocyclododecane congeners (HBCD-alpha, beta, gamma);
- 25 mycotoxins naturally produced by strains of mould in the field and/or during the storage of foodstuffs of plant origin: groups B and G, and M1 aflatoxins, fumonisins B1 and B2, ochratoxin A and B and patulin, trichothecenes from groups A (T-2 toxin, HT-2 toxin, diacetoxyscirpenol (DAS), monoacetoxyscirpenol (MAS)) and B (nivalenol (NIV), deoxynivalenol (DON), de-epoxy derivative of DON (DOM-1),

3-acetyl-deoxynivalenol (3-Ac-DON), 15-acetyl-deoxynivalenol (15-Ac-DON) and fusarenon X (FusX)), zearalenone and its metabolites;

- 11 phytoestrogens naturally found in plants: isoflavones (genistein, daidzein, equol, formononetin, glycitein, biochanin A), lignans (matairesinol, secoisolariciresinol, enterolactone), coumestans (coumestrol), and natural stilbenes (resveratrol);
- 283 active plant protection substances used for agricultural reasons, including 62 priority substances in terms of the surveillance of dietary exposure as part of the work of the French Observatory for Pesticide Residues;
- 12 additives used as processing aids during food transformation or storage and considered as priorities by the EC: annatto (E160b), nitrites (E249-250), sulfites (E220, E221, E222, E223, E224, E226, E227 and E228), and tartaric acid (E334)
- 21 heat-induced compounds: acrylamide, which is formed during food processing, and 20 congeners of polycyclic aromatic hydrobarbons (PAHs), which can be of environmental origin (combustion) or formed during food processing (drying, smoking, cooking): benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[ghi]perylene, benzo[a]pyrene, chrysene, cyclopenta[cd]pyrene, dibenz[a,h]anthracene, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, indeno[1,2,3-cd]pyrene, 5-methylchrysene, anthracene, pyrene, fluoranthene, benzo[c]fluorene, phenanthrene;

At the time of the study, some substances could not be included on the list of interest (phthalates, bisphenol A, etc.), notably due to a lack of appropriate analytical tools. Since the food samples from TDS 2 have been preserved, it should be noted that additional analytical work has since been undertaken for certain substances of interest. For example, various endocrine disruptors (phthalates, bisphenol A) are currently being investigated.

TDS surveys are undertaken in some thirty countries around the world (Australia, Cameroon, Canada, China, Spain, United States, New Zealand, Czech Republic and the United Kingdom, among others).

Some of the substances that were analysed in the French TDS 2 are not tested in the TDS surveys undertaken by other countries. For instance, the French TDS 2 included 14 more inorganic contaminants and minerals than the last TDS undertaken in the United States, as well as mycotoxins, phytoestrogens, dioxins and furans, PAHs, brominated compounds, additives and acrylamide. Compared to the TDS undertaken in the United Kingdom, which is implemented yearly for various substances, the French TDS 2 also analysed mycotoxins and additives.

Certain inorganic contaminants, gallium (Ga) and tellurium (Te), as well as certain phytoestrogens and certain mycotoxins, such as fumonisins and patulin, have not been included in any of the TDS surveys undertaken in other countries.

Conversely, the French TDS 2 did not analyse certain substances that are analysed in the TDS survey in the United States for example (radionuclides, melamine, furan, volatile organic compounds).

Regarding the foods that were studied

TDS 2 used the food consumption data from the INCA 2 study (AFSSA, 2009a; Dubuisson *et al.*, 2010; Lioret *et al.*, 2010). This study described the dietary habits of adults and children over the age of 3 years in France: foods consumed and quantities.

Food sampling was undertaken at the start of TDS 2, based on the INCA 2 study's data (Sirot *et al.*, 2009). Two main criteria were considered: (i) the most heavily-consumed foods and (ii) foods not heavily consumed but likely to be highly contaminated. A total of 212 different food types were thus selected, covering around 90% of dietary consumption in the adult and child populations.

Out of these 212 food types, which included beverages including tap water and bottled water, 116 were considered as having no or little inter-regional variability (composition or contamination). The other 96 foods were the subject of inter-regional lists in order to take into account potential variability in composition or contamination between the regions (production and/or animal feeding methods, environmental pressure). Eight inter-regional food lists were thus drawn up.

For each of the 212 food types, a sampling plan was followed taking into account consumption habits in France, the flavour, the product's origin, claims such as 'low-fat' or 'organic' for example, points of purchase (hypermarket or supermarket, retail shops, markets), the storage method (fresh, deep-frozen, canned), the market shares of the various brands, and so on. Purchases were made year-round, from June 2007 to January 2009, thus covering seasonal variations in food supply. Lastly, each sample was purchased twice during the study, in order to cover potential seasonal variability in composition or contamination. In the end, approximately 20,000 foods were purchased in some thirty large towns across mainland France (Annex 2).

For each food, only the edible part was used, and then the foods were prepared 'as consumed'. For example, fruits and vegetables were washed. Vegetables, meat and seafood products were cooked: braised, pan-fried, grilled, baked, deep-fried, etc. The foods were then combined into 1319 composite samples representative of shopping baskets and consumer purchases for the eight surveyed inter-regions and analysed by accredited laboratories. These analyses led to the production of over 230,000 analytical results, after relevant substances were tested in the various samples: each substance was thus tested in those foods that were known or assumed to contain it according to the scientific literature.

Food analyses were undertaken by around a dozen laboratories chosen for their capacities (national reference laboratories and accredited laboratories) for most of the tested substances in the targeted foods.

Regarding the analysis of results

The results of the sample analyses were used to calculate both nutritional intake and exposure to chemical contaminants for each consumer. This calculation was made in accordance with WHO's international recommendations, by combining the INCA 2 study's consumption data with the analytical results. When the analytical technique was unable to detect or quantify a substance in a significant percentage of the analysed foods, two assumptions were used in order to assess exposure: a lowerbound assumption and an upperbound assumption, in accordance with the guidelines (GEMS-Food Euro, 1995). The lowerbound assumption 'under estimates' levels and thus exposure[1], while the upperbound assumption 'over estimates' levels and thus exposure[2] and is therefore 'conservative' in terms of risk assessment. An intermediary assumption was used in the other cases, when the substance could be quantified in most of the analysed foods.

The exposure and intake levels that were thus calculated were compared with reference values in order to characterise risks for various populations:

- for contaminants: acceptable daily intake (ADI), tolerable daily intake (TDI), provisional tolerable weekly intake (PTWI), provisional tolerable monthly intake (PTMI), no effect level or benchmark dose limit (BMDL), etc., established by French, European or international scientific authorities: these various notions are covered by the more generic term of health-based guidance value in this opinion;
- for nutritional intake: estimated average requirement (EAR), derived from the population reference intake, to assess the risk of insufficient intake, and the tolerable upper intake level (UL) to assess the risk of excess intake.

For nutritional aspects, French population reference intakes were used (Martin *et al.*, 2001). For tolerable upper intake levels, the values defined in Europe and, if not available, then in France, were given preference (Martin *et al.*, 2001; EFSA, 2006). For chemical contaminants, values chosen at the French, European or international levels were given preference. When several authorities proposed different reference values, the value (or values where applicable) considered as being the most relevant was used, after consultation of ANSES' expert committees. In certain cases, no available value was considered to be suitable for the assessment of chronic risk as investigated in this study. For some of the substances that were studied in TDS 2, questions have been raised regarding a possible endocrine disrupting effect (brominated compounds, perfluorinated compounds, certain pesticides, etc.), and they are currently being investigated to identify and characterise the possible hazards.

Regarding the interpretation of results and the study's limits

TDS 2 assessed intake and exposure through food and drinking water in the general population. The risk assessments whose results are presented in this study took only this route of exposure into account. They did not take into account exposure through other routes (respiratory, dermal, etc.). It is estimated that for most of the substances that were studied, food is the main route of exposure in the general population. Nevertheless, questions have been raised for certain substances for which exposure through other routes should be studied.

The study reflects the state of intake and exposure levels at the time of the survey which, in accordance with international recommendations, were extrapolated to assess long-term risks. TDS 2 did not aim to assess the population's short-term intake and exposure. The TDS 2 method also did not assess intake and exposure due to particular situations such as food contamination in a local geographic region or accidental contamination. It did not identify specific risks related to the consumption of 'organic' products or imported products, for example.

TDS 2 assessed intake and exposure related to consumption habits as described in INCA 2, without considering the use of food supplements, uncommon cooking/preparation methods or practices (i.e. barbecue), special diets (i.e. enriched foods) or other specific individual cases. It accounted for intake and exposure in the general population, i.e. in children over the age of 3 and in adults aged 18 to 79 years, but not in specific population groups such as children under the age of 3 and pregnant women in particular. Children under the age of 3 years, who were not included in the INCA 2 consumption survey, are the subject of a specific TDS that was launched by ANSES in 2010.

In TDS 2, the potential cumulative effects of various substances were taken into account when there were health-based guidance values for a set of substances (as in the case of certain environmental contaminants such as dioxins and PCBs).

The study's food sampling covered around 90% of food consumption in France. The remaining 10% concerned foods that are not heavily consumed by the general population (i.e. quenelles, avocado, horse meat, duck, apple turnovers) and that did not appear to be likely to significantly contribute to intake and exposure in the general population for the targeted substances, as high-contribution foods were included in the sampling plan.

Moreover, the survey period (7 days) resulted in uncertainty regarding the characterisation of very low and very high intake or exposure levels.

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[1] Lowerbound assumption: a non-detected substance is considered as absent, and a detected but non-quantified substance is considered as present at the limit of detection.

[2] Upperbound assumption: a non-detected substance is considered as present at the limit of detection, and a detected but non-quantified substance is considered as present at the limit of quantification.

The presentation of results does not systematically reflect the variability of proportions of the population whose intakes are lower than their requirements (prevalence of inadequate nutritional intake). Moreover, various variables (age, gender, etc.) can result in differences, such that for example, a prevalence of inadequate iron intake that appears high in adults in the results is in fact the result of very high prevalence in women but very low prevalence in men. With certain exceptions, this level of detail by age group and gender does not appear in the report.

To facilitate interpretation of risk characterisation, a classification into three categories was proposed for all of the substances (Table 1):

- risk that can be ruled out for the general population;
- risk that cannot be ruled out for certain specific consumer groups in the general population, when the results show that a statistically significant proportion (even small) of the adult and/or child population risks exceeding the health-based guidance value;
- situations where neither the risk itself nor the coverage of requirements can be determined, particularly for substances that do not have robust health-based guidance values, nutrients for which no population reference intakes or ULs were defined, or when a lack of analytical precision required the use of different assumptions and could not rule out a risk (no risk under the lowerbound assumption but risk of exceeding under the upperbound assumption).

Table 1. Risk characterisation classification

What conclusion?	In what cases?
1. Risk can be ruled out	• Health-based guidance value not exceeded • No risk of inadequate nutritional intake compared to requirements
2. Risk cannot be ruled out	• Health-based guidance value exceeded • Risk of inadequate nutritional intake compared to requirements, or UL exceeded
3. No conclusion can be drawn	• No robust health-based guidance value, UL, or defined requirement, or no characterisation of exposure • Health-based guidance value exceeded, using the upperbound assumption, overestimating exposure

Analysis and conclusions

This section presents the intake and exposure results and their interpretation by group of substances. Each section successively presents trends in exposure *versus* TDS 1 or the Agency's previous assessments if an assessment has already been undertaken, and then gives conclusions regarding risks. Lastly, where applicable, a few specific points are addressed, particularly concerning risk management challenges or research requirements.

Inter-regional exposure differences are not shown, and will be analysed later.

Inorganic contaminants

Sixteen inorganic contaminants were analysed (Table 2), and were detected in 70% of the 22,000 analyses. For various inorganic contaminants common to TDS 1 and TDS 2 (Leblanc *et al.*, 2005a), the results show that exposure was higher than in TDS 1 (cadmium, aluminium, antimony, nickel, cobalt). This increase ranged from +25% (nickel) to +400% (cadmium). For certain elements (nickel and aluminium), the hypotheses that could explain this trend include the use of stainless steel and aluminium materials to prepare the samples in TDS 2, unlike in TDS 1. Changes in food consumption could also explain these differences. For cadmium, the results underline the need for further contamination studies to identify the reasons for the observed increases (cereal products in particular). For other contaminants (lead, mercury and arsenic), the results show a decrease in the population's exposure compared to TDS 1.

For some elements, and particularly inorganic arsenic, cadmium and lead, risk cannot be ruled out for certain consumer groups (Table 2). For these three contaminants, the risk assessment was based on health-based guidance values that were recently revised downward by the competent international expert committees. Although exposure to arsenic and lead decreased *versus* TDS 1, it still appears necessary to continue undertaking efforts in order to reduce exposure to these three elements, and particularly the contamination of foods identified as chief contributors (lead: water, coffee, non-alcoholic beverages, etc.; inorganic arsenic: water, coffee, milk, etc.; cadmium: bread and dried bread products, potatoes, etc.).

Moreover, analytical methods are necessary to screen for the various organic and inorganic forms of tin, arsenic and mercury.

Lastly, for certain elements (tin, gallium, germanium, strontium, silver, tellurium, vanadium), no conclusions can be made as to the risk related to dietary exposure due to a lack of robust toxicological data. For these elements, it would be advisable to undertake necessary toxicological studies, particularly for tin, strontium and vanadium.

Minerals

Twelve minerals were analysed in TDS 2 and were detected in 88% of the 14,500 analyses. The nutritional role of vanadium and cobalt remains poorly determined to date, so these two substances were not analysed from a nutritional standpoint.

For most of the minerals that were studied, risks of insufficient or excess intakes cannot be ruled out for certain population groups (Table 3).

For example, sodium intake (primarily from the consumption of salted products) remained too high in relation to the French and international guidance values[3]. The intake limit was also exceeded for zinc, by a small but significant percentage.

Table 2. Risk assessment conclusions for exposure to inorganic contaminants

<table>
<tr><th>Substances</th><th>Primary results</th><th>Corrective actions and/or research requirements</th></tr>
<tr><td>Antimony, Barium, Nickel</td><td>Risk can be ruled out for the general population</td><td>-</td></tr>
<tr><td>Cobalt</td><td>Risk can be ruled out for the general population</td><td>• Need to carry out studies on carcinogenicity and genotoxicity (due to uncertainty).</td></tr>
<tr><td>Inorganic mercury</td><td>Impossible to draw a conclusion as to risk related to dietary exposure</td><td rowspan="2">• Need to continue efforts to reduce dietary exposure.
• Need to lower the analytical limits for mercury and lead.
• Need to put in place routine analytical methods for speciation in foodstuffs for arsenic and mercury.
• Need to identify the origin of the contamination increase for cadmium.</td></tr>
<tr><td>Cadmium, Aluminium, Methylmercury, Inorganic Arsenic, Lead</td><td>Risk cannot be ruled out for certain consumer groups (Cadmium: adults; Aluminium, Lead and Inorganic Arsenic: the most exposed adults and children; Methylmercury: large consumers of tuna)</td></tr>
<tr><td>Tin, Gallium, Germanium, Strontium, Silver, Tellurium, Vanadium</td><td>Impossible to draw a conclusion as to risk related to dietary exposure</td><td>• Need to undertake long-term toxicological studies on oral exposure.
• Need to put in place routine analytical methods for speciation in foodstuffs for tin.</td></tr>
</table>

Table 3. Risk assessment conclusions related to mineral intakes

<table>
<tr><th rowspan="2">Substances</th><th colspan="2">Primary results</th><th rowspan="2">Corrective actions and/or research requirements</th></tr>
<tr><th>Risk of excess intake</th><th>Risk of insufficient intake</th></tr>
<tr><td>Sodium</td><td>Risk cannot be ruled out for certain consumer groups (adults and children with the highest intakes)</td><td>-</td><td>• Need to continue efforts to reduce dietary intakes</td></tr>
<tr><td>Chromium</td><td>Impossible to draw a conclusion as to risk related to dietary intake</td><td>Impossible to draw a conclusion regarding coverage of requirements for CrIII</td><td>• Need to undertake long-term toxicological studies on oral exposure.
• Need to put in place routine analytical methods for speciation in foodstuffs for chromium.</td></tr>
<tr><td>Lithium, Manganese, Potassium, Molybdenum</td><td>Risk can be ruled out for the general population</td><td>Impossible to draw a conclusion regarding coverage of requirements</td><td>• Need for additional data to establish relevant requirement levels.</td></tr>
<tr><td>Zinc</td><td>Risk cannot be ruled out for children</td><td>Risk cannot be ruled out for certain consumer groups (Zinc: children; Selenium: the elderly)</td><td rowspan="4">• Need to relate this data to that concerning the nutritional status.
• Need to reassess requirements for calcium, copper, iron and magnesium.</td></tr>
<tr><td>Selenium</td><td>Risk can be ruled out for the general population</td><td rowspan="3">Risk cannot be ruled out for certain consumer groups (Copper: children; Calcium: adolescents; Iron: women and girls; Magnesium: adults and children with the lowest intakes) but uncertainties remain regarding requirements</td></tr>
<tr><td>Copper</td><td>Risk cannot be ruled out for certain consumer groups (adults and children with the highest intakes)</td></tr>
<tr><td>Calcium, Iron, Magnesium</td><td>Risk can be ruled out for the general population</td></tr>
</table>

[3] Mean sodium intake was estimated at 2.65 g per day in adults and at 2.0 g per day in children; 26% of adults and 7% of children exceeded the French guidance value (3.15 g sodium per day, or 8 g salt), and 58% of adults and 25% of children exceeded WHO's guidance value (2.36 g sodium per day, or 6 g salt).

Concerning copper, depending on the population in question, intakes were either too high in relation to the tolerable upper intake level or conversely lower than the nutritional requirement.

For selenium, the risk of insufficient intake cannot be ruled out for the elderly. For zinc, it cannot be ruled out for children.

For calcium, iron, magnesium and copper, high percentages of the population had intakes that were lower than the nutritional requirements (up to 74% for iron in some children). Based on these data alone however, it is not possible to draw a conclusion as to the presence or absence of risk for the general population, as the nutritional requirements related to these substances still need to be explored. These data underline the need to asses the nutritional status of the population through the use of biomarkers. These findings should nonetheless be put into perspective insofar as:

- the TDS 2 sampling covered only around 90% of diets in France, and as a result, some intakes were underestimated. Indeed, for minerals, they can also be found in foods that are very seldom consumed but that considerably contribute to intake;
- for some nutrients, more recent scientific data suggest that the nutritional requirements should be reassessed. In the current state of knowledge, some elements do not appear to pose any particular clearly identified public health problems related to inadequate intake.

As for lithium, manganese, potassium and molybdenum, since no nutritional requirements have been defined, no conclusions can be drawn regarding their coverage. This demonstrates the need to undertake dedicated work in order to define relevant nutritional requirements for these minerals.

Furthermore, analytical methods are required to screen for the various forms of chromium (CrIII and CrVI). For chromium, no risk conclusions can be drawn due to a lack of toxicological data. Necessary toxicological studies should be undertaken.

The results are consistent with previous observations made by ANSES, and highlight the importance of pursuing efforts to reduce sodium intakes and increase intakes of calcium, iron and selenium in certain consumer groups.

Persistent organic pollutants

Dioxins and PCBs

Seventeen congeners of dioxins and furans, 12 congeners of DL-PCBs, and 6 congeners of NDL-PCBs were analysed and were detected in 86% of the 20,000 analyses. The results of TDS 2 show a significant decrease in exposure to dioxins and PCBs in the French population (by a factor of around 4) *versus* the previous 2005 and 2007 assessments, based on the results of government surveillance and monitoring plans (raw, unprepared foods) (AFSSA, 2005b, 2007). This trend is consistent with the decrease in both food and environmental contamination observed in Europe and around the world, and certainly reflects the effectiveness of the European management measures implemented to reduce contamination.

However, a small but significant proportion of consumers (<5%) had exposure levels that exceeded the health-based guidance values, and therefore risk cannot be ruled out (Table 4). It would therefore be advisable to continue undertaking efforts in order to reduce exposure to dioxins and PCBs.

Brominated compounds

Hexabromocyclododecane (HBCD): three HBCD congeners were analysed and were detected in 49% of the 1700 analyses. Estimated exposure in this study could not be interpreted, in the absence of data to establish a health-based guidance value for HBCD. It is therefore not possible, at the present time, to draw a conclusion as to the risk related to this compound. It would be advisable to undertake long-term toxicological studies on oral exposure in order to establish a health-based guidance value.

Polybrominated biphenyls (PBBs): three PBB congeners were analysed and were detected in 8% of the 1,700 analyses. Based on the estimated exposure levels for PBBs, risk related to dietary exposure can be ruled out.

Polybrominated diphenyl ethers (PBDEs): eight PBDE congeners were analysed and were detected in 76% of the 4,600 analyses, depending on the congener. The population's exposure to PBDEs appeared to be 12 to 15 times lower than the estimation made in 2006 by the Agency for the general population on the basis of the INCA 1 study's consumption data and French

Table 4. **Risk assessment conclusions for exposure to persistent organic pollutants**

Substances	Primary results	Corrective actions and/or research requirements
PBBs	Risk can be ruled out for the general population	-
PBDEs, PFOS and PFOA	Risk can be ruled out for the general population	• Need to undertake long-term toxicological studies on oral exposure
Other perfluorinated compounds, HBCD	Impossible to draw a conclusion as to risk related to dietary exposure (no health-based guidance values)	• Need to undertake long-term toxicological studies on oral exposure
Dioxins and PCBs	Risk cannot be ruled out for certain consumer groups (the most exposed adults and children)	• Need to continue efforts to reduce dietary exposure

and international contamination data (AFSSA, 2006). Risk related to PBDE exposure can be ruled out for the general population. Nevertheless, it would be advisable to continue research into the toxicity of these compounds.

Perfluorinated compounds

Sixteen perfluorinated compounds were analysed. Fourteen were the subject of an assessment, and were detected in 0 to 9% of the analyses (8,700 in total), depending on the congener. On the basis of the available health-based guidance values, risk related to PFOA and PFOS exposure can be ruled out for the general population (Table 4). Nevertheless, it would be advisable to continue research into the toxicity of these compounds, and particularly their carcinogenic and endocrine disrupting potential.

It would be advisable to undertake long-term *ad hoc* toxicological studies on oral exposure for the other perfluorinated compounds, to establish health-based guidance values.

Mycotoxins

Twelve mycotoxins were assessed in TDS 1 (Leblanc *et al.*, 2005b) and were again assessed in TDS 2. Furthermore, 13 new substances or derivatives were assessed and detected in 6% of the 7,700 analyses. Regarding ochratoxin A, nivalenol, patulin and zearalenone, the results showed a decrease in the population's exposure to these mycotoxins compared to TDS 1. Several hypotheses can be considered to explain this trend. These include the introduction, in 2006, of regulations setting maximum levels for certain mycotoxins in foodstuffs (aflatoxins, ochratoxin A, deoxynivalenol, zearalenone, fumonisins, T-2 and HT-2 toxins).

Estimated exposure to fumonisins and aflatoxins in TDS 2 was equivalent to that estimated in TDS 1, whereas exposure to deoxynivalenol increased. For deoxynivalenol, one hypothesis is that the weather conditions were unfavourable before the sampling period.

These results show that risk can be ruled out for the general population for ochratoxin A, aflatoxins, patulin, nivalenol, fumonisins and zearalenone (Table 5). However, it cannot be ruled out for deoxynivalenol and its acetylated derivatives, for which the exposure calculations showed that health-based guidance values were exceeded.

For T-2 and HT-2 toxins, it is not possible to draw a risk conclusion in that the health-based guidance values were exceeded only under the upperbound assumption which overestimates levels and therefore exposure. Analytical performance is considered insufficient for T-2 and HT-2 toxins, as was underlined in the Agency's report in 2009 (AFSSA, 2009b). It would be advisable to continue efforts to increase the sensitivity of analysis so as to better quantify these mycotoxins in certain foods that are likely to contain them, and particularly cereal-based products, and in order to rule out the risk of exceeding the health-based guidance values.

In the absence of health-based guidance values, it was also not possible to draw a conclusion for 4 other mycotoxins (ochratoxin B, fusarenon X, diacetoxyscirpenol and monoacetoxyscirpenol). For these substances, it is therefore necessary, as the Agency concluded in 2009 for trichothecenes, to obtain conventional toxicological data, analytical data and exposure data to characterise risk to humans (AFSSA, 2009b).

Lastly, mycotoxin levels in foods depend heavily on variations in weather conditions over the years. This conclusion warrants the undertaking of periodic surveys to draw a conclusion as to exposure trends for the mycotoxins assessed in TDS 2.

Phytoestrogens

Eleven phytoestrogens, whose main contributors are soy-based products, were assessed in TDS 2 and detected in 20% of the 3,700 analyses (1 to 60%, depending on the substance).

The intake levels estimated in TDS 2 for the general population were lower than the maximum intake limit proposed by the Agency in 2005 (AFSSA, 2005c). However, some adults and children who consumed large amounts of soy-based products (soy beverages, soy desserts, tofu, etc.) had intakes that reached this maximum intake limit. Thus, it appears that while risk can be ruled out for the general population, it cannot be ruled out for this category of consumer (Table 6).

It would be advisable to continue research into the potentially harmful effects of these substances, to obtain more data (particularly for dairy products), to improve the quantification of their levels in complex foods (offal)

Table 5. Risk assessment conclusions for exposure to mycotoxins

Substances	Primary results	Corrective actions and/or research requirements
Ochratoxin A, Aflatoxins, Patulin, Nivalenol, Fumonisins, Zearalenone	Risk can be ruled out for the general population	-
Deoxynivalenol and acetylated compounds (15-ac-DON and 3-Ac-DON)	Risk cannot be ruled out for certain consumer groups (the most exposed adults and children)	• Need to continue efforts to reduce dietary exposure
T-2 and HT-2 toxins	Impossible to draw a conclusion as to risk related to dietary exposure	• Need to lower the analytical limits

or foods requiring reconstitution (tea, coffee) and to more narrowly assess the exposure of regular consumers of soy-based products through a consumption study specific to this population.

Moreover, the new data on the effects of phytoestrogens (particularly on bones) show a need to re-assess the maximum intake limit that was proposed in 2005. It may therefore become possible to take into account the oestrogen effects of lignan metabolites, whose intakes, particularly through dairy products, are not negligible.

Pesticide residues

Two hundred and eighty-three substances were analysed in 194 of the 212 types of foods studied in TDS 2. Two hundred and ten (74%) were not detected, either because they were not present in the analysed foods, or because they could not be detected due to insufficient analytical performance. Seventy-three substances were detected in less than 1% of the 146,000 analyses. In half of the analysed foods, at least one substance was detected. The most frequently detected priority substances were pirimiphos-methyl, chlorpyrifos-methyl, chlorpyrifos-ethyl, iprodione, carbendazim and imazalil. These substances were authorised in the European Community and used in France at the time of sampling.

Health-based guidance values were defined for 254 of these substances, which were therefore the subject of a risk characterisation. Lacking health-based guidance values for the 29 other substances, no risk conclusions can be drawn. However, they were not detected in the TDS 2 foods or in the surveillance plans.

For 244 substances, risk can be ruled out for the population (Table 7). Out of the 10 other substances, 6 were authorised in Europe and in France during the sampling period.

The health-based guidance value was exceeded for only one substance under the lowerbound assumption, which underestimates levels and therefore exposure. This was dimethoate, which is authorised as an insecticide for the treatment of vines and fruit and vegetable crops. This exceeded health-based guidance value was linked to the detection of dimethoate in cherries and affected only large cherry consumers: risk therefore cannot be ruled out but should nonetheless be put into perspective in relation to actual consumption of this fruit throughout the year.

For the 9 other substances (dithiocarbamates, ethoprophos, carbofuran, diazinon, methamidophos, disulfoton, dieldrin, endrin and heptachlor), it is not possible to draw a risk conclusion due to exposure levels that exceeded

Table 6. **Risk assessment conclusions for phytoestrogen intake**

Substances	Primary results	Research requirements
Isoflavones, Coumestrol, Equol	Risk can be ruled out for the general population	• Need to re-assess the maximum intake limit. • Need to undertake a study on high consumption of soy products. • Improve analytical techniques for the quantification of levels in complex matrices and matrices as consumed.
Lignans	Impossible to draw a conclusion as to risk related to dietary intake	• Need to assess the oestrogen effects of metabolites. • Improve analytical techniques for the quantification of levels in complex matrices and matrices as consumed.
Natural stilbenes	Impossible to draw a conclusion as to risk related to dietary intake	• Improve analytical techniques for the quantification of levels in complex matrices and matrices as consumed.

Table 7. **Risk assessment conclusions for exposure to pesticides**

Substances	Primary results	Corrective actions and/or research requirements
HCH*, Iodofenphos, Mecarbam, Methidathion*, Mevinphos*, Mirex, Monocrotophos*, Oxydemeton-methyl*, Parathion*, Parathion-methyl, Phorate*, Phosphamidon*, Prothiofos, Pirimiphos-ethyl, Quinalphos*, Toxaphene* + 228 other screened substances	Risk can be ruled out for the general population	-
Dimethoate*	Risk cannot be ruled out for certain consumer groups	• Need to revise the authorised uses and/or maximum residue levels. • Need to lower the analytical limits.
Dithiocarbamates*, Ethoprophos, Carbofuran*, Diazinon*, Methamidophos, Disulfoton*, Dieldrin*, Endrin*, Heptachlor*	Impossible to draw a conclusion as to risk related to dietary exposure	• Need to lower the analytical limits.

* Priority substances.

the health-based guidance values in the case of the upperbound assumption, which overestimates levels and therefore exposure.

To date, out of these 10 substances, only dimethoate, ethoprophos and most dithiocarbamates are still authorised for use in Europe. The Maximum Residue Levels (MRLs) for all of these substances are currently being revised by the European Food Safety Authority (EFSA).

ANSES therefore recommends undertaking supplementary analyses, in accordance with the Agency's recent recommendations (2010) for regulatory surveillance plans, lowering the analytical limits for these 10 substances, in order to refine the calculation of exposure.

Additives

Twelve additives divided into four groups were screened and detected in the foods analysed in TDS 2. Additives were detected in 3 to 42% of the analyses (524 in all) depending on the additive.

For three of the additive groups that were studied (tartaric acid, nitrites and annatto), risk for the general population can be ruled out on the basis of the exposure results (Table 8).

However, a small percentage of adults (3%) exceeded the ADI for sulfites, primarily due to the consumption of wine (around 70% of sulfite intake) and certain alcoholic beverages. This finding suggests that efforts should be continued to reduce exposure by decreasing the use of sulfites and by lowering high consumption of alcohol.

Acrylamide

Acrylamide was detected in 11% of the 192 analysed samples. In both adults and children, estimated exposure to acrylamide in TDS 2 was lower than that which had been calculated by the Agency in 2005 for the French population (AFSSA, 2005a). This estimation had been based on the INCA 1 consumption data and occurrence data from surveillance and monitoring plans undertaken by government bodies and industry. Exposure decreased by 14% for adults and 45% for children on average. The hypotheses that could explain this trend include a decrease in acrylamide levels in fried starchy foodstuffs and coffee, and, in children, a significant decrease in the consumption of chips and potatoes cooked in oil, the main contributing foods, between INCA 1 and INCA 2.

On the basis of the results however, a risk for certain consumers cannot be ruled out, considering the 2010 reassessment of the international reference values (Table 9). It would therefore be advisable to continue with efforts to reduce dietary exposure to acrylamide, a substance whose hazards have been recognised internationally for several years. It is necessary to continue monitoring exposure to acrylamide and encourage epidemiological studies.

Polycyclic aromatic hydrocarbons (PAHs)

Twenty PAHs were tested in TDS 2. The detection of PAHs was highly variable depending on the congener, with congeners detected in 0 to 19% of the analyses (2500 in total).

The results show a general decrease (by more than half) in dietary exposure to 6 of the PAHs[4], *versus* the Agency's estimation in 2003 on the basis of the INCA 1 consumption data and the data from surveillance plans (AFSSA, 2003).

The results indicate that risk related to PAH exposure (aside from specific practices such as barbecue cooking) can be ruled out for the population (Table 9). However, for certain PAHs such as benzo[a]pyrene, which are carcinogenic and genotoxic with no threshold, the risk, even if very low, cannot be considered as nonexistent.

Table 8. Risk assessment conclusions for exposure to additives

Substances	Primary results	Corrective actions
Annatto, Tartaric acid, Nitrites	Risk can be ruled out for the general population	-
Sulfites	Risk cannot be ruled out for certain consumer groups (large consumers of alcohol)	• Need to reduce the use of sulfites and for large consumers, to reduce the consumption of wine and certain alcoholic beverages.

Table 9. Risk assessment conclusions for exposure to heat-induced contaminants

Substances	Primary results	Corrective actions and/or research requirements
PAHs	Risk can be ruled out for the general population	-
Acrylamide	Risk cannot be ruled out for certain consumer groups (the most exposed adults and children)	• Need to continue efforts to reduce dietary exposure and undertake epidemiological studies.

[4] Benz[a]anthracene, benzo[b+j]fluoranthene, benzo[k]fluoranthene, benzo[ghi]perylene, benzo[a]pyrene, dibenz[a,h]anthracene.

The Agency's conclusions and recommendations

The TDS 2 study presents a snapshot of nutritional intake and information on long-term dietary exposure to chemical contaminants in the French population.

The TDS 2 study is an unprecedented source of information in terms of the number of screened substances and the wide variety of sampled foods. The report associated with this opinion explains the method that was used and presents, for each substance taken into account, its origin, a hazard characterisation, the chief foods that contribute to consumer exposure, and a risk assessment related to this exposure on the basis of the available health-based guidance values.

This study will be used by the Agency for multiple purposes in the upcoming months and years, while the immediate publication of its detailed results for the public authorities, industrialists and stakeholders will offer them useful insight.

The Agency can already use this work to draw various conclusions and formulate some recommendations. In general, for chemical substances, the TDS 2 results highlight a good level of control over the health risks related to food consumption in France.

For the following substances, compared to TDS 1 and other assessments undertaken by the Agency, TDS 2 highlights:

- decreased exposure: inorganic arsenic, lead, manganese, molybdenum, PBDEs, dioxins and PCBs, ochratoxin A, patulin, nivalenol, zearalenone, acrylamide, PAHs;
- increased exposure: antimony, nickel, cobalt, cadmium, aluminium, lithium, chromium, copper, magnesium, deoxynivalenol;
- unchanged exposure: mercury, sodium, zinc, selenium, calcium, aflatoxins, fumonisins.

Out of the 445 analysed substances, 433 warranted a toxicological risk assessment. The other 12 substances, minerals of nutritional interest, warranted both an assessment of the risk of inadequate intake and an assessment of the risk of excess intake.

Out of the former 433 substances, 361 could be assessed. For 307 of them (85%), on the basis of available knowledge and an assessment of dietary intake alone, risk can be ruled out for the general population. For 54 substances (15%), risk cannot be ruled out for certain consumer groups.

Out of the 12 minerals, 11 were the subject of a risk assessment related to excess intake, and 6 were the subject of a risk assessment related to insufficient intake. For 8 of them, risk of excess intake can be ruled out; for 3 of them, risk of excess intake cannot be ruled out. For the 6 minerals assessed to that end, risk related to insufficient intake cannot be ruled out.

When risk can be ruled out

When exposure levels were lower than the health-based guidance values, it was concluded that risk could be ruled out for the general population. This was particularly the case for antimony, barium, nickel, cobalt, PBBs, PBDEs, PFOS and PFOA, certain mycotoxins (ochratoxin A, aflatoxins, patulin, nivalenol, fumonisins, zearalenone), 244 pesticide residues out of 254 assessed, PAHs, annatto, tartaric acid, and nitrites. These results should nonetheless be confirmed by maintaining surveillance to verify potential contamination or exposure levels as appropriate. Some health-based guidance values will need to be re-assessed, particularly in relation to recent toxicological data. In any case, it is necessary to encourage any efforts that will reduce levels of contaminants in foods.

When risk cannot be ruled out

For various substances, it was concluded that risk could not be excluded for certain specific consumer groups in the general population (Annex 4).

This was particularly the case for lead, cadmium, inorganic arsenic, aluminium, methylmercury, sodium, dioxins and PCBs, deoxynivalenol and its derivatives, acrylamide, sulfites and dimethoate. These findings are consistent with those established by other authorities that have assessed the risks related to some of these substances (EFSA, JECFA, FSA, NZFSA, etc.). Moreover, it should be remembered that the health-based guidance values for most of these substances have been revised downward over the past few years.

Some foods were identified as high contributors to exposure to several of those substances for which risk cannot be excluded. These may be foods that are not necessarily highly contaminated but that are heavily consumed. For example, for some substances, the main contributors were bread (cadmium, lead, DON and derivatives) and pasta (aluminium), coffee for adults (copper, inorganic arsenic and acrylamide) and milk for children (lead, inorganic arsenic). Risk management actions aimed at reducing the levels of these contaminants in the main contributing foods (regulations and actions targeting given sectors) should be pursued.

Other foods contributed significantly to exposure to certain substances since they were the foods with the highest levels. This was the case of fatty fish, for dioxins and PCBs, and tuna, for methylmercury. For these foods, it is advisable to follow the fish consumption recommendations issued by ANSES [5,6]. These recommendations ensure optimal coverage of nutritional requirements while limiting the risk of over-exposure to chemical contaminants.

(5) Opinion of the French Food Safety Agency of 14 June 2010 regarding the benefits/risks of fish consumption.

(6) Avis de l'Agence française de sécurité sanitaire des aliments du 17 avril 2009 relatif à l'interprétation des résultats d'analyses du plan de surveillance des contaminants chimiques 2007, notamment la recherche de mercure dans les lamproies et les différentes espèces de Sélaciens.

When no conclusion can be made

For some elements, it was not possible to draw a risk conclusion. This was particularly the case for inorganic mercury, tin, gallium, germanium, strontium, silver, tellurium, vanadium, certain perfluorinated compounds, HBCD, 38 pesticide residues and 6 mycotoxins, either because there was no robust health-based guidance value, or due to an incomplete characterisation of exposure (Annex 5). For these substances, it would be advisable to undertake additional studies or analytical developments, on a case-by-case basis, in order to remove uncertainty related to risk. For several of these substances, risk management actions aimed at reducing the levels of these contaminants in the main contributing foods (regulations and actions targeting sectors) should also be pursued.

Nutritional conclusions and recommendations

Regarding sodium, a risk of excess intake cannot be ruled out for certain consumer groups (Annex 6). It would thus be advisable to continue efforts to reduce intake, by reducing the salt content of the main contributors (bread and dried bread products, delicatessen meats, etc.).

A risk of insufficient intake could not be ruled out for calcium, magnesium, iron, selenium, copper and zinc. A risk of excess intake cannot be ruled out for zinc and copper.

Lastly, it was not possible to draw a conclusion regarding the risk of insufficient intake for lithium, manganese, potassium, chromium and molybdenum, either because nutritional requirements have not been estimated or because not enough is yet known about intake. For these substances, it would be advisable to undertake studies or analytical developments, on a case-by-case basis.

Regarding phytoestrogens, risk can be ruled out for the general population. Nevertheless, it would be advisable to undertake specific studies to assess intake levels in large consumers of soy-based products.

General conclusions and recommendations

It appears necessary to obtain biological surveillance data for most of the analysed substances, in order to better characterise actual exposure levels, all routes combined, and refine the assessment of health risks.

In light of recent improvements to toxicological knowledge, particularly regarding potential endocrine disrupting effects, it will be necessary to re-examine this study's conclusions subsequent to the reassessment of certain health-based guidance values for certain substances.

Moreover, it appears necessary to undertake specific studies to estimate exposure levels in certain sensitive population groups, such as young children and pregnant women.

Given the fact that cumulative effects were only taken into account when toxicological interpretations were available, work is necessary in order to improve the understanding of these effects. Likewise, it would be advisable to further take into account the various routes of exposure in the risk assessment of the analysed substances.

As far as consumers are concerned, this study shows that nutritional and chemical risks can be minimised by avoiding the regular consumption of a small number of foods in large quantities. In this respect, the study confirms recommendations encouraging consumers to diversify their diets.

Keywords
Exposure, surveillance, general population, pesticides, additives, inorganic contaminants, minerals, environmental contaminants, mycotoxins, phytoestrogens

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Annexes

Annex 1. List of the 212 types of foods

Food group	Type of foods	Type
Offal	Liver	Regional
Dietetic foods	Tofu	National
Other hot beverages	Instant hot chocolate drink	Regional
	Sweet cocoa powder for chocolate drink	Regional
	Tea or herbal tea	Regional
Butter	Butter	National
	60-62 % low-fat butter	National
	Salted butter	National
Sweet or savoury biscuits and bars	Fruit pulp biscuits	National
	Aperitif biscuit	National
	Dry biscuit	National
	Dry chocolate biscuit	National
	Salted potato crisps	Regional
Alcoholic beverages	Beer	National
	Champagne	National
	Cider	National
	Ready-mixed pastis	National
	Wine	National
Non-alcoholic beverages	Soy drink	National
	Drinks made from herbal tea extracts	National
	Fizzy orange juice drink with pulp	National
	Still orange drink	National
	Pineapple juice made from concentrate	National
	Multivitamin fruit juice from 100% pure juice	National
	Apple juice from pasteurised concentrate	National
	Orange juice from pasteurised concentrate	National
	Fresh unsweetened orange juice	National
	Lemonade	National
	Pure pasteurised grape juice	National
	Syrup with fruit extracts to be diluted	National
	Soda	National
Coffee	Black coffee	Regional
	Instant soluble coffee	Regional
Breakfast cereals	Chocolate cereals	National
	Muesli	National
	Cornflakes	National
Delicatessen meats	Chipolata	Regional
	Foie gras	Regional
	Ham	Regional
	Cooked ham	Regional
	Lard, bacon	Regional
	Spicy lamb sausage (merguez)	Regional
	Pâté	Regional
	Frankfurter sausage	Regional
	Dried sausage	Regional
Chocolate	Chocolate biscuit bar	National
	Milk chocolate	National
	Milk chocolate with dried fruit	National
	Dark chocolate	National
	Chocolate spread	National

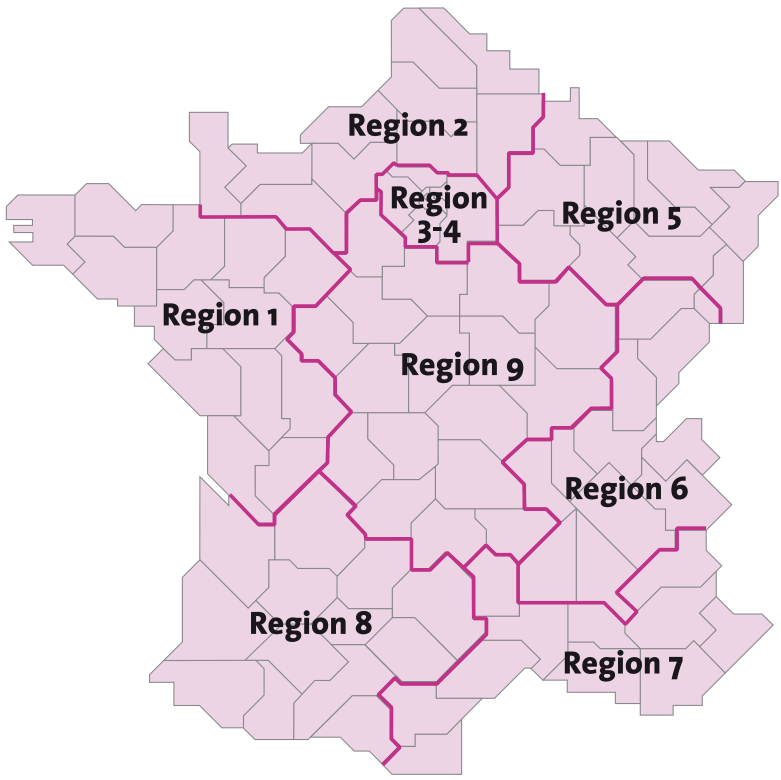
Food group	Type of foods	Type
Compotes and cooked fruit	Reduced sugar stewed fruit compote	National
	Non-apple stewed fruit compotes	National
	Apple compote	National
	Canned fruit in syrup	National
Seasonings and sauces	Ketchup	National
	Mayonnaise	National
	Soy sauce	National
	Tomato meat sauce	National
	Meat-free tomato sauce	National
	Vinaigrette	National
Crustaceans and molluscs	Scallop	Regional
	Shrimp	Regional
	Oyster	Regional
	Boiled mussels	Regional
Water	Sparkling mineral water	National
	Still mineral water national brand 1	National
	Spring water	Regional
	Tap water	Regional
	Still mineral water national brand 2	National
	Still mineral water national brand 3	National
	Perrier	National
	Still mineral water national brand 4	National
	Still mineral water national brand 5	National
Dairy-based desserts	Chocolate dairy dessert (viennois or liégois)	National
	Fruit clafoutis	Regional
	Creme caramel	National
	Cream dessert	National
	Chocolate-flavoured soya dessert	National
	Soy-based dessert with fruit	National
	Natural soya dessert	National
	Egg custard	Regional
	Refrigerated chocolate mousse	National
Cheese	Camembert and related cheeses	National
	Cantal, morbier and related cheeses	National
	Goat cheese	National
	Edam and related cheeses	National
	Fromage blanc (not low-fat)	Regional
	Cheese and mini cheeses	National
	Cheese spread	National
	Gruyere	National
	Roquefort	National
Fruit	Apricot	Regional
	Banana	National
	Cherry	Regional
	Clementine or mandarin	National
	Strawberry	Regional
	Kiwi	National
	Melon	Regional
	Fresh orange	National
	Grapefruit	National
	Peach	Regional
	Pear	Regional
	Fresh apple	Regional
	White grapes	Regional

Food group	Type of foods	Type
Dried fruits, nuts and seeds	Dried fruit	National
	Oilseed	National
Ice cream, sorbets and frozen desserts	Ice cream	National
Oils	Rapeseed oil	National
	Soybean oil	National
	Sunflower oil	National
	Virgin olive oil	National
	Mixed oils	National
Milk	Semi-skimmed milk	Regional
	Skimmed milk	Regional
	Whole milk	Regional
Vegetables (excluding potatoes)	Artichoke	Regional
	Carrot	Regional
	Celery	Regional
	Celeriac	Regional
	Cauliflower	Regional
	Cucumber	Regional
	Courgette	Regional
	Endive	Regional
	Spinach	Regional
	Mung bean sprouts	National
	Bean	Regional
	Corn	Regional
	Turnip	Regional
	Onion	Regional
	Peas	Regional
	Leek	Regional
	Pepper	Regional
	Radish	Regional
	Ratatouille	Regional
	Lettuce	Regional
	Tomato	Regional
Pulses	White beans	Regional
	Lentils	Regional
Margarine	Low-fat margarine	National
	Sunflower margarine in a tub	National
Eggs and egg products	Scrambled eggs, omelette	Regional
	Boiled egg	Regional
Bread and dried bread products	Baguette	National
	Rusk	National
	Multigrain bread	National
	Granary or wholemeal bread	National
	Farmhouse bread	National
	Packaged, sliced bread	National
	Toast	National
Pasta	Pasta	National
	Egg pasta	National
Pastries and cakes	Fruitcake	National
	Choux pastry cake	National
	Pancake or waffle	National
	Pancake with sugar	National
	Cake	National
	Chocolate cake	National
	Soft cake, filled or not	National
	Soft chocolate cake	National
	Tart or tartlet	National
Pizzas, quiches and savoury pastries	Pizza	National
	Quiche lorraine	National

Food group	Type of foods	Type
Mixed dishes	Cassoulet (meat and bean casserole)	Regional
	Dressed sauerkraut	Regional
	Poultry cordon bleu	Regional
	Garnished couscous	Regional
	Savoury pancake	Regional
	Soy-based vegetable cutlet	National
	Shepherd's pie	Regional
	Paella	Regional
	Ravioli type stuffed pasta	Regional
	Meat and vegetable stew (Pot-au-feu)	Regional
	Industrial tabbouleh	Regional
	Veal	Regional
Fish	Pollack or coley	Regional
	Fried breaded fish	Regional
	Salmon	Regional
	Smoked salmon	Regional
	Tuna	Regional
	Canned tuna	Regional
Potatoes	Boiled potatoes	Regional
	Sauteed potatoes or chips	Regional
	Mashed potato	Regional
Rice and wheat products	Precooked durum wheat	National
	Rice	National
	Semolina	National
Sandwiches and snacks	Hamburger	Regional
	Sandwich	Regional
Soups and broths	Vegetable soup (in carton)	National
	Homemade vegetable soup	Regional
	Chicken noodle soup	Regional
	Cream of tomato soup	National
Sugars and sugar derivatives	Sweets	National
	Jam	National
	Honey	National
	Sugar	National
Ultra-fresh dairy products	Cream	Regional
	Fermented milk and yoghurt drinks	Regional
	Yoghurt (zero fat)	Regional
	Whole milk yoghurt	Regional
	Semi-skimmed milk yoghurt	Regional
Meat	Beef steak	Regional
	Pork chop	Regional
	Lamb	Regional
	Roast pork	Regional
Croissant-like pastries	Brioche cake and bread	National
	Chocolate croissant	National
	Croissant	National
Poultry and game	Duck	Regional
	Sautéed turkey cutlet	Regional
	Roast turkey	Regional
	Chicken	Regional

Annex 2.
Division of mainland France into 8 inter-regions and primary cities selected for the sampling

Major regions	Administrative regions	Cities selected
1. West	Bretagne Pays de la Loire Poitou-Charentes	Rennes, Poitiers, Nantes, Brest
2. North west	Basse-Normandie Haute-Normandie Nord - Pas-de-Calais Picardie	Caen, Lille, Rouen, Amiens
3-4. Île-de-France	Île-de-France	Paris, Pontoise, Melun
5. East	Champagne-Ardenne Lorraine Alsace	Reims, Metz, Strasbourg, Nancy
6. Center east	Franche-Comté Rhône-Alpes	Besançon, Lyon, Saint-Étienne, Grenoble
7. South east	Provence - Alpes - Côte d'Azur Languedoc-Roussillon	Marseille, Perpignan, Nice, Montpellier
8. South west	Midi-Pyrénées Aquitaine	Toulouse, Bordeaux, Pau, Montauban
9. Center	Centre Bourgogne Limousin Auvergne	Orléans, Dijon, Limoges, Clermont-Ferrand
- National	–	Paris and suburbs



Annex 3.
List of selected substances according to whether or not they were regulated and whether or not they had a health-based guidance value

	Substances regulated in certain foodstuffs (n=361)	Substances not regulated in foodstuffs (n=84)
Substances having a health-base guidance value or other reference value (in terms of toxicological risk) (n=380)	• Inorganic contaminants [7]: aluminium*, antimony**, arsenic**, barium**, cadmium, mercury, nickel**, lead. • Minerals: copper*, iron*, manganese*, selenium**, sodium*. • Dioxins and furans [7]. • DL-PCBs [7]. • Mycotoxins [7]: aflatoxins from groups B and G and M1, fumonisins B1 and B2, ochratoxin A, patulin, trichothecenes (T-2 toxin, HT-2 toxin, deoxynivalenol (DON)) and zearalenone. • 254 pesticide residues [8]. • Additives [9]: annatto, nitrites, sulfites, tartaric acid. • Heat-induced contaminants [7]: Acrylamide**, PAHs (benzo[a]pyrene, benzo[b]fluoranthene*, benzo[k] fluoranthene*, benzo[ghi]pe-rylene*, indeno[1,2,3-cd]pyrene*). (n=327)	• Inorganic contaminants: cobalt. • Minerals: calcium, lithium, magnesium, molybdenum, potassium, zinc. • NDL-PCBs. • Perfluorinated compounds: PFOA, PFOS. • Brominated flame retardants: PBDE, PBB. • Phytoestrogens: isoflavones (genistein, daidzein, equol, formononetin, glycitein, biochanin A), coumestanes (coumestrol). • Mycotoxins: ochratoxin B, trichothecenes (diacetoxyscirpenol, monoacetoxyscirpenol, nivalenol, de-epoxy derivative of DON, 3-acetyl-deoxynivalenol, 15-acetyl-deoxynivalenol, fusarenon X), metabolites of zearalenone. • Heat-induced contaminants: PAHs (benz[a]anthracene, benzo[j] fluoranthene, chrysene, cyclopenta[cd] pyrene, dibenz[a,h]anthracene, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, 5-methylchrysene, anthracene, pyrene, fluoranthene, benzo[c]fluorene, phenanthrene). (n=53)
Substances with no reference value for toxicological risk (n=65)	• Minerals: chromium**. • Pesticides [8]: allethrin, anthraquinone, bioallethrine, chlormephos, chloropropylate, cyanofenphos, cyanophos, desmetryne, di-allate, dichlofenthion, dienochlor, dioxacarb, ditalimfos, ketone-endrin, fenson, fluvalinate, formothion, furalaxyl, 3-hydroxycarbofuran, isazofos, monalide, nitrofen, pentachloroanisole, pentachlorophenol acetate,oxon-phosmet, tetrasul tribromoanisole, tribromophenol (2,4,6), trichloronat.	• Inorganic contaminants: tin, gallium, germanium, strontium, silver, tellurium, vanadium. • Perfluorinated compounds: PFBA, PFPA, PFHxA, PFHpA, PFNA, PFDA, PFUnA, PFDoA, PFTrDA, PFTeDA, PFBS, PFHxS, PFHpS, PFDS. • Brominated flame retardants: HBCD. • Phytoestrogens: lignans, natural stilbenes. (n=31)

* or **: substances regulated in drinking water only, quality reference (*) or quality limit (**)
(French Order of 11 January 2007 on quality limits and references for untreated water and water intended for human consumption mentioned in Articles R. 1321-2, R. 1321-3, R 1321-7 and R 1321-38 of the French Public Health Code, and French Order of 28 December 2010 amending the French Order of 14 March 2007 on quality criteria for packaged water, treatment and special labelling requirements for packaged natural mineral and spring waters and natural mineral water distributed in public fountains).

[7] Commission Regulation (EC) No. 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs, amended by Regulations (EC) Nos. 1126/2007, 565/2008, 629/2008, 105/2010, 165/2010, 420/2011.

[8] Regulation (EC) No. 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC, amended by Regulations (EC) Nos. 178/2006, 260/2008 and 299/2008.

[9] European Parliament and Council Directive No. 95/2/EC of 20 February 1995 on food additives other than dyes and sweeteners, amended by Directives 96/85/EC, 98/72/EC, 2001/5/EC, Regulation 1882/2003, Directives 2003/114/EC, 2006/52/EC, 2010/69/EU, and corrected by Corrigendum OJ L 78 of 17.3.2007.

Annex 4.
Substances for which toxicological risk cannot be excluded

Group of substances	Substances	Population concerned	Main contributing foods
Inorganic contaminants	Lead	The most exposed adults and children	• Adults: alcoholic beverages (14%), bread and dried bread products (13%), water (11%). • Children: water (11%), milk (11%), non-alcoholic beverages (10%).
	Cadmium	<1% of adults and 15% of children	• Adults: bread and dried bread products (22%), potatoes (12%). • Children: potatoes (14%), bread and dried bread products (13%).
	Inorganic arsenic	The most exposed adults and children	• Adults: water (24-27%), coffee (14-16%). • Children: water (19-24%), milk (11-17%), non-alcoholic beverages (10-12%).
	Aluminium	<1% of adults and 2% of children	Adults: Hot drinks other than coffee (13%), vegetables excluding potatoes (11%). Children: vegetables excluding potatoes (8%), pasta (7%), pastries and cakes (6%).
	Organic mercury (methylmercury)	Large consumers of tuna (<1% of adults and 1% of children)	-
Dioxins and PCBs	Dioxins and DL-PCBs	<1% of adults and <1% of children	• Adults: fish (20%), butter (20%). • Children: butter (20%), fish (14%).
	NDL-PCBs	<1% of adults and 2% of children	• Adults: fish (37%), butter (11%), cheese (11%), ultra-fresh dairy products (11%). • Children: fish (30%), butter (12%), meat (11%).
Additives	Sulfites	Large consumers of wine (3% of adults)	-
Mycotoxins	DON and derivatives	<1% of adults and 5 to 10% of children	• Adults: bread and dried bread products (60%). • Children: bread and dried bread products (40%).
Heat-induced compounds	Acrylamide	The most exposed adults and children	• Adults: sautéed potatoes or chips (45%), coffee (30%). • Children: sautéed potatoes or chips (61%), biscuits (19%).
Pesticide residues	Dimethoate	Large consumers of cherries (<1% of adults and children)	-

Annex 5. Substances for which it is impossible to draw a risk conclusion, due to a health-based guidance value only being exceeded under the upperbound assumption*

Group of substances	Substances	Population concerned	Main contributing foods
Inorganic contaminants	Inorganic mercury	1% of children	• Potential contributors: water and milk
Mycotoxins	T-2 Toxin	<1% of adults and 11% of children	• Adults: pasta (44%), bread and dried bread products (18%). • Children: pasta (46%).
	HT-2 Toxin	4% of adults and 35% of children	• Adults: bread and dried bread products (61%), pasta (23%). • Children: bread and dried bread products (40%), pasta (36%).
Pesticide residues	Dithiocarbamates, Ethoprophos, Carbofuran, Diazinon, Methamidophos, Disulfoton, Dieldrin, Endrin, Heptachlor	From <1% of adults and children (dithiocarbamates) to 98% of adults and 97% of children (dieldrin)	• Potential contributors: fruits and vegetables, non-alcoholic beverages.

* Assumption that 'overestimates' exposure (see Section 2 and Table 1). Under the upperbound assumption, remember that exposure is overestimated, due to conservative assumptions of levels, and that exposure should be refined to confirm or exclude a risk.

Annex 6. Minerals for which a risk cannot be excluded

Substances	Type of risk	Population concerned	Main contributing foods
Sodium	Excess intake	26 to 58% of adults and 7 to 25% of children, depending on the guidance value	• Adults: bread and dried bread products (30%), delicatessen meats (11%). • Children: bread and dried bread products (19%), delicatessen meats (11%).
Zinc	Excess intake	Children (1%)	• Meat (25%), milk (10%)
	Insufficient intake	Children	
Selenium	Insufficient intake	The elderly	• Adults: water (27%), coffee (9%)
Copper	Excess intake	3% of adults and <1% of children	• Adults: coffee (36%). • Children: pasta (13%), bread and dried bread products (6%), offal (6%), chocolate (6%), water (6%).
	Insufficient intake	Children	
Calcium	Insufficient intake	Adolescents	• Children: milk (26%), ultra-fresh dairy products (13%), cheese (13%).
Iron	Insufficient intake	Women and girls	• Adults: bread and dried bread products (16%), meat (10%). • Children: meat (10%), bread and dried bread products (9%).
Magnesium	Insufficient intake	Adults and children with the lowest intakes	• Adults: bread and dried bread products (11%), coffee (9%), vegetables excluding potatoes (7%). • Children: milk (9%), bread and dried bread products (7%).

Glossary

Population reference intake, estimated average requirement (EAR)
The population reference intake is the nutritional intake that covers almost all (97.5%) of the healthy population's requirements. The EAR is the required quantity of a nutrient for the proper functioning of the body (healthy individual). It is an individual value.

Detected/Quantified
A substance is said to be 'detected' when the analysis highlighted its presence in a food. A substance is said to be 'quantified' when it was detected and its level is sufficiently high to be quantified. If the level is very low and the analytical device is not capable of quantifying it, it is only said to be 'detected'.

Acceptable Daily Intake (ADI)
The Acceptable Daily Intake (ADI) was defined by WHO as the quantity of a substance that can be ingested daily, over a lifetime, without any risk for consumer health. The ADI applies to substances that are voluntarily added to foodstuffs, such as additives (added for technological reasons such as for food storage), pesticides (added for plant protection reasons) and veterinary medicinal products (added for animal health reasons). Their presence in foods can thus be expected. For each use, a value or maximum authorised limit is thus defined by the regulations on the basis of the ADI.

Tolerable Daily Intake (TDI), Tolerable Weekly Intake (TWI), Tolerable Monthly Intake (TMI)
The Tolerably Daily Intake (TDI), Tolerable Weekly Intake (TWI) and Tolerable Monthly Intake (TMI) correspond to the quantity of a substance that can be respectively ingested every day, every week or every month over a lifetime, without any risk to consumer health. They are used for substances whose presence in foodstuffs is not intended or is inevitable (environmental contaminants of anthropogenic origin or otherwise, PCBs, heavy metals, etc.). The TWI and TMI can be qualified as 'provisional' (PTWI and PTMI) when the toxicological data available at the time of their establishment are considered incomplete by the assessing authorities.

Composite sample
A group of 15 food products prepared 'as consumed', analysed for one or more substances of interest.

Maximum Residue Level (MRL)
Regulatory limit corresponding to the maximum level of pesticide residue likely to be found in a food product, after application of a pesticide in accordance with good agricultural practices.

Tolerable Upper Intake Level (UL)
The Tolerable Upper Intake Level corresponds to the maximum quantity of a nutrient that an individual can regularly consume without risks to his health over his lifetime.

Heat-induced (contaminant)
Undesirable substance which can appear during industrial or domestic thermal treatment (cooking, etc.).

Food product
Foods purchased in mainland France and prepared 'as consumed'.

Risk of insufficient intake
There is risk of insufficient intake in a population when a high percentage of this population has a nutritional intake lower than its requirements.

Food type
Category of foods considered not to have major differences in composition or contamination for the analysed substances. For example, the food type 'dry chocolate biscuit' encompasses chocolate-filled biscuits, coated biscuits and biscuits with chocolate chips.

Health-based guidance value
The Health-based guidance value corresponds to an acceptable level of exposure to a chemical substance. It is a generic term that groups together values used to establish a relationship between a dose and an effect (threshold dose effect) or a dose and the likelihood of an effect's occurrence (no-threshold dose effect). Health-based guidance values are specific to an effect (critical effect), an exposure period and a route of exposure. They are set by international authorities such as the World Health Organization (WHO), by national expert assessment agencies such ANSES, or by European expert assessment agencies such as the European Food Safety Authority.

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