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To cite this version:

Luc Pussemier, Peter Harcz, Ludwig de Temmerman, Simon de Voghel, Nadia Waegeneers, et al.. Contaminants in organically and conventionally produced winter wheat (Triticum aestivum) in Belgium. Food Additives and Contaminants, 2007, 24 (07), pp.713-720. 10.1080/02652030601185071 . hal-00577544

HAL Id: hal-00577544
https://hal.science/hal-00577544

Submitted on 17 Mar 2011

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Journal:	*Food Additives and Contaminants*
Manuscript ID:	TFAC-2006-293.R1
Manuscript Type:	Original Research Paper
Date Submitted by the Author:	13-Dec-2006
Complete List of Authors:	Pussemier, Luc; Veterinary and Agrochemical Research Center, Quality and Safety Harcz, Peter; Veterinary and Agrochemical Research Centre (CODA-CERVA), Leuvensesteenweg 17, 3080 Tervuren, Belgium, Quality and safety De Temmerman, Ludwig; Veterinary and Agrochemical Research Center, Ecochemistry de Voghel, Simon; Veterinary and Agrochemical Research Center, Ecochemistry Waegeneers, Nadia; Veterinary and Agrochemical Research Center, Ecochemistry Wilmart, Olivier; Federal Agency for the Safety of the Food Chain (FASFC), WTC III, Boulevard Simon Bolivar 30 Vromman, Valérie; Federal Agency for the Safety of the Food Chain (FASFC), WTC III, Boulevard Simon Bolivar 30 Schmit, Jean-François; Federal Agency for the Safety of the Food Chain (FASFC), WTC III, Boulevard Simon Bolivar 30 Moons, Emmanuelle; Federal Agency for the Safety of the Food Chain (FASFC), WTC III, Boulevard Simon Bolivar 30 Van Peteghem, Carlos; Ghent University, Pharmacy Department De Saeger, Sarah; Ghent University, Pharmacy Department Schneider, Yves Jacques; Université catholique de Louvain, Laboratoire de biochimie cellulaire, Institut des Sciences de la Vie Larondelle, Yvan; Université catholique de Louvain, Unité de biochimie de la nutrition

Additives/Contaminants:	Heavy metals, Mycotoxins, Pesticide residues
Food Types:	Cereals

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Contaminants in organically and conventionally produced winter wheat (*Triticum aestivum*) in Belgium

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Running Head : Contaminants in wheat

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Abstract

A database has been compiled with the levels of important contaminants (mycotoxins, heavy metals and pesticides) measured from 2002 to 2005 in winter wheat (*Triticum aestivum*) grown in Belgium according to the organic and conventional farming systems. Assuming no further change in contaminant levels during cereal processing and during the preparation of foodstuffs, conservative intakes are estimated for the consumers of cereal-based products such as flour, bread, breakfast cereals, dough and pastry. The results show that for the consumer of organic foodstuffs, estimated daily intakes are 0.56 µg deoxynivalenol (DON), 0.03 µg zearalenone (ZEA), 0.19 µg Cd , 0.28 µg Pb and 0.0006 µg Hg kg^{-1} body weight, taking into account the average contaminant levels in unprocessed grains and the average cereal products consumptions in Belgium. For the consumers of conventional foodstuffs, the corresponding estimated daily intakes are 0.99 µg DON, 0.06 µg ZEA, 0.17 µg Cd, 0.12 µg Pb and 0.0007 µg Hg kg^{-1} bw. In addition, it appears that for the consumers of conventional products, intakes of some post-harvest insecticides have to be taken into account (0.11 µg chlorpyriphos-methyl, 0.2 µg dichlorvos and 0.24 µg pirimiphos-methyl kg^{-1} bw). When expressed as a percentage of the tolerable/acceptable daily intake (TDI/ADI), it seems that the corresponding estimated (conservative) intakes are the highest for DON (56 % for organic and 99 % for conventional cereal products), ZEA (16% for organic and 32% for conventional cereal products) and Cd (19% for organic and 17% for conventional cereal products), all other estimated intakes of contaminants (including pesticides) being lower than 10% of the TDI/ADI.

Key words: Contaminants**,** mycotoxins, heavy metals, pesticides, intake, wheat, cereal products, organic, Belgium

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Introduction

Cereals and derived products (bread, flour, breakfast cereals, dough, pastry…) are important commodities susceptible to be contaminated by a number of contaminants such as pesticides, mycotoxins and environmental pollutants, with some differences occurring depending on the farming system (organic or conventional) (Pussemier *et al*. 2006a).

In Belgium, cereals are cultivated on 320,000 ha, which represents 38 % of the total arable lands. Winter wheat (*Triticum aestivum*) occupies 203,000 ha and is the main cereal produced for food purposes. Organic farming in Belgium exists on 24,000 ha, which is equal to 1.72% of the country's cultivated area and 19% of this area is devoted to cereals (FPS-Economy 2004).

Mycotoxins and particularly some *Fusarium* toxins, such as trichothecenes and zearalenone (ZEA) are important contaminants of the cereal crops (European Commission 1999). Trichothecene contamination starts in the field as a consequence of *Fusarium graminearum* and *F. culmorum* attacks during flowering of the cereals. Wet weather years are known to increase the contamination by deoxynivalenol (DON), one of the most important trichothecenes (European Commission 1999b). In 2001, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) established for DON a tolerable daily intake (TDI) of 1 µg/kg bw based on a chronic toxicity study in mice (JECFA 2001). The proposed limit in processed cereals is 750 µg/kg. For ZEA, the Scientific Committee for Food (SCF) of the European Commission established a temporary tolerable daily intake (tTDI) of 0.2 µg ZEA kg^{-1} bw, on the basis of a short-term study in pigs (SCF 2000).

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Environmental contaminants encompass several chemicals such as heavy metals and persistent organic pollutants (POPs). Heavy metals such as Cd, Pb and Hg can contaminate crops in industrialized areas as a result of air and soil pollution whilst POPs are more of a problem for animal products because of their bioaccumulation properties and concentration in fat. The Global Environment Monitoring System/Food Contamination Monitoring Assessment Program of the World Health Organization (WHO 2002) (GEMS/Food) has classified heavy metals as priority food contaminants. Cadmium is a contaminant found in various compartments of the environment in general and in the soil in particular due to erosion, industrial activities and agricultural practices (phosphate fertilizers, sewage sludge spreading). It has been classified in category 1 (carcinogenic to humans) by the International Cancer Research Agency (IARC 1993). In 2003, the JECFA confirmed the Provisional Tolerable Weekly Intake (PTWI) of 7 µg kg^{-1} bw. Lead is an environmental pollutant found above all in the soil and atmosphere in the vicinity of industrial sites. It is a metabolic poison, which targets the haematopoietic system, the nervous system, the kidneys and the male reproductive system. In 2000, the JECFA confirmed the PTWI of 25 µg kg^{-1} bw. The main sources of mercury environmental exposure are degassing of the Earth's crust and volcanic activity. Anthropogenic releases are essentially due to exploitation of lead and zinc mines, combustion of fossil fuels and industrial waste. Mercury is a neurotoxic substance that causes retarded psychomotoric development in children. The PTWI of total Hg is 5 µg kg^{-1} bw (JECFA 1999).

Pesticide residues in food usually result from a field application of a given pesticide to the crop that gives the food commodity but post-harvest treatment during storage is also an important cause for the presence of residues in foodstuffs. Consumer risk assessment is a crucial element in the approval, registration or licensing of pesticide uses on food crops. However, scientific studies, most of the time carried out on animals (rodents) and based on

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life-term exposure, struggle to supply accurate data on human cancer induced by pesticides. Thus the prediction models of the tumorigenic potential for different classes of chemicals remain open to questions (Hughes 2002). Scientific data on pesticide-induced immunotoxicity through diet exposure are scarce. However, various studies have assessed immune system disruptions due to pesticide exposures (Galloway *et al.* 2003). Finally, Keifer *et al.* (1997) have pointed out adverse effects of pesticides on the neurological system.

Organic farming is an alternative to reduce pesticide residues in the food chain. Baker *et al.* (2002) have observed a better situation in organic farming in terms of residue levels, number of detected residues and multi-contaminated samples, but still residues of non-synthetic pesticides (sulphur, pyrethrum, bromides) can be found in organic commodities (Pussemier *et al.* 2006a). It was also highlighted that organic products are likely to be slightly contaminated through the environment. Indeed, accumulation of POPs (dioxins, PCB, DDT, 'drins, HCH's,…) in the soil can affect free-range animals in organic farming (Van Overmeire *et al.* 2006) while drifts from sprays in adjacent fields account for potential exposure to pesticides. On this basis, one can consider that both production systems may show some vulnerability (Magkos *et al*. 2006).

In the context of the present study, the consumer exposure estimates obtained were compared with the appropriate TDIs or ADIs to assess the safety of cereals and cereal products consumed by the Belgian population. Contaminants dealt with were the mycotoxins DON and ZEA, the heavy metals Cd, Pb and Hg, and three frequently used post-harvest insecticides applied in cereals (chlorpyrifos-methyl, dichlorvos and pirimifos-methyl). The aim of this study is to make a tentative comparison of risks linked to several classes of toxicants susceptible to contaminate the cereal crops. The worst case approach adopted in this study (unprocessed cereals instead of cereal-based foodstuffs) does not entirely fit with the

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requirements needed to perform a refined exposure assessment of the consumers of Belgian cereals. Still, it makes it possible to compare several classes of contaminants (mycotoxins, heavy metals and pesticides) and several modes of production (organic and conventional) for cereals produced under Belgian conditions.

Materials and methods

Databases on contaminant levels in winter wheat

The contaminant database with levels of mycotoxins, heavy metals and pesticides in winter wheat grown in Belgium was built by gathering data from various sources. For DON and ZEA, conventionally and organically produced grain samples were sampled (harvest 2002 and 2003) and analyzed as described by Pussemier *et al*. (2006b). Additional mycotoxin results (sampling at random) were obtained for the years 2002-2005 from the Federal Agency for the Safety of the Food Chain (FASFC, unpublished data). In order to build up a database for Cd, Pb and Hg, analyses were performed on cereals grown in Belgium during the years 2002 – 2005 (226 samples for Cd and Pb and 168 samples for Hg). Most of the organic samples were taken in the same plots as for the mycotoxin study but additional conventional samples were taken at random in different parts of the Country. Fresh ground samples were analysed for their mercury content in a mercury analyser AMA 245 (Altec, Prague, Czech Rep.). Dried ground samples were analysed for Cd and Pb contents by Inductive Coupled Plasma – Mass Spectrometer (ICP-MS) (VG PQ Excell, Thermo Elemental, Winsford, UK). The samples were first decomposed with nitric acid in hermetical sealed vessels (TFM® 50 mL, Matthews, NC, USA). During decomposition in a microwave furnace (CEM Mars X-Press Matthews, NC, USA), the samples were heated to 180°C in 15 min, and this temperature was maintained for 30 min (Pizzolon *et al*. 2005). The accuracy of the method was tested with a reference "Durum wheat flour" (National Institute of Standards and Technology, NIST 8436, Gaithersburg, MD, USA).

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Pesticide results were acquired from the "Pesticide Residue Monitoring Program" achieved in 2002-2004 by the FASFC (unpublished data). Nineteen pesticides in 2002, twenty-eight pesticides in 2003 and twenty-nine pesticides in 2004 were searched for in 28 (2002), 50 (2003) and 7 (2004) raw cereal samples, respectively. All contaminant analyses of samples taken by FASFC were carried out according to the requirements of the ISO17025 quality, by officially accredited laboratories (see the website of the national accreditation body BELAC (http://belac.fgov.be/beltest/home_en.htm) for certificates of accreditation). The results involved in the present study correspond only to three insecticides, namely chlorpyriphos-methyl, dichlorvos and pirimiphos-methyl, because only for these three pesticides detectable levels were found on each year of the survey.

All results are expressed in µg/kg of fresh matter. Data are reported as mean ± standard deviation (SD), percentiles (median, 95th) and maximum. In these calculations, values below the limit of detection (LOD) were treated as being equal to LOD/2, and levels above LOD but below the limit of quantification (LOQ) were treated as being equal to (LOD + LOQ)/2 (Kroes *et al*. 2002). For pesticides, the non-quantifiable (<LOQ) values were treated as being equal to LOQ/2, as the LOD values were not available.

Statistical analysis attempted to determine the presence of significant differences in contamination between conventional and organic cereal samples, using non-parametric Mann-Whitney-test.

Database on the consumption of cereal products in Belgium

Data from a food consumption survey recently carried out in Belgium (http://www.iph.fgov.be/epidemio/) have been used to estimate cereal and cereal product

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intakes for the average population with different sex, age and levels of consumption. The cereal and cereal products contained subgroups, like flour, pasta, bread, breakfast cereals, dough and pastry. 3083 people older than 15 years were interviewed and 6166 days of intake were considered. The average consumption of cereals and cereal products was 185 g/day. The 25th, 50th, 75th, 97.5th, 99th percentiles and maximum of consumption were 133, 175, 228, 367, 418 and 1360g/day, respectively.

Determination of intake and risk assessment

Intakes were estimated by multiplying food consumption data for the whole Belgian population or specifically for the consumers of cereals and cereal products by the average concentrations of a contaminant found in each relevant foodstuff. The use of average mycotoxin, heavy metal and pesticide residue concentration in the intake calculations provides a realistic and appropriate estimation of the long-term exposure, since these intakes are compared with the reference toxicological intake (TDI) (FAO/WHO 1997). Because of the numerous non-quantified and not detected values and the mathematical assumptions made concerning these data (see above), the values obtained with respect to risk quantification should be interpreted with caution. Note also that the contaminant levels were determined on unprocessed cereals, which constitutes a worst-case scenario for a potential exposure since it often happens that a significant part of the contaminant load is removed during processing (Schollenberger *et al*. 2005).

The purpose of the risk characterisation is to compare the average level, the median or even the 95th percentile level of the exposure with the reference toxicological values established by the national, European or international scientific expert committees. The results obtained are expressed as daily intake (in µg/kg bw) or as contribution to the TDI (in percent). Taking into

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account the different body weight values proposed in neighbouring countries (SCOOP 2002), the intake calculations were carried out for an adult of 66 kg body weight.

Results and discussion

The contaminant levels in cereals grown in Belgium during the years 2002-2005 are shown in Table I, II and III for the selected mycotoxins, heavy metals and pesticides, respectively.

[Insert table I about here]

[Insert table II about here]

[Insert table III about here]

For mycotoxins, we confirm here, on a larger data set, some results already published (Pussemier *et al.* 2006b). Indeed, no significant differences ($p > 0.05$) were obtained between mycotoxin (DON and ZEA) concentrations in conventionally and organically produced cereals even if the average levels and the calculated percentiles were systematically higher for the conventional cereals. Regarding heavy metals, concentrations of Cd and Hg were not significantly different. By contrast, Pb concentrations were significantly higher ($p < 0.05$) in organically produced cereals. The main reason for the difference can be found in the sampling process. There was, indeed, very seldom a location where we found organic as well as conventional grown wheat. As such a full comparison of both results is difficult to make. It must be stressed that lead contamination of wheat is primarily from airborne origin and most likely the lead dust is deposited on the kernels during harvesting in dry conditions. To some extent the average atmospheric deposition of lead could be different between organic and conventional fields as the largest fields of conventional wheat are situated in area's with low population and traffic density whereas organic farming takes mostly place on a much smaller scale in areas with a higher population and traffic density. However, there is no indication that

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this explanation would fully account for the differences. In terms of pesticides, the results obtained for 3 insecticides, namely chlorpyriphos-methyl, dichlorvos and pirimiphos-methyl, were included in this study. These pesticides were analysed only in conventional samples. The reason why synthetic pesticides were only searched for in conventionally grown cereals lies in the fact that they are not allowed in organically grown cereals. Accordingly, a study carried out by the Scientific Committee of the FASFC clearly showed that in Belgium organic foodstuffs contain much lower amounts of these residues, as compared to foodstuffs obtained through conventional farming (Pussemier *et al.* 2006a). During its "Pesticide Residue Monitoring Program", the FASFC searched for the residues of numerous (from 19 to 29) pesticides in cereals. In 2002, twenty-two out of twenty-eight samples, in 2003, fourty-six out of fifty, and in 2004, three out of seven samples, were without detectable residues. The results involved in the present study correspond only to the three insecticides listed above, because detectable levels of these compounds were found in each year of the survey, which may be explained by the fact that they are classically used during the storage of conventional cereals.

Table IV shows that the estimated average DON intake of the Belgian population is 0.56 and 0.99 µg DON kg^{-1} bw with consumption of organic and conventional cereal foodstuffs, respectively.

[Insert table IV about here]

The corresponding 97.5th percentile exposure is 1.11 and 1.97 µg DON kg^{-1} bw, respectively. These values can be compared with existing Belgian data (SCOOP 2003), where the vectors contributing to the exposure of adolescents (13-18 years) are mainly cereal products (bread, pasta, bran). The average daily intake was reported to be 0.24 µg DON kg^{-1} bw and the high level (95th percentile) exposure was 0.84 µg DON kg^{-1} bw. The discrepancy between these previous results and ours is not likely to be due to the difference in the target population (adolescents versus general population) since teenagers are believed to eat more cereal-derived products than other population groups. The fact that the contaminant levels were

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determined in unprocessed cereals in our study and thus do not take the removal of DON during processing is a first element that could explain the higher intake obtained in this study. In addition, it must be pointed out that 48 out of 117 samples of this study were taken during the year 2002 which was a wet year characterized by high concentrations of DON in harvested wheat (Pussemier *et al.* 2006b).

As far as ZEA is concerned no information is available to date concerning the intake by the consumers in Belgium. The SCOOP 3.2.10 (2003) study however provides some information on the intake in the neighbouring countries. Thus, it appears that in the Netherlands the daily average ZEA intake is 0.020 µg kg^{-1} bw while, in France, it ranges from 0.024 to 0.029 µg kg^{-1} bw. This is again less than what is observed in the present study (0.03 and 0.06 µg kg^{-1} bw for consumers of organic and conventional cereal based products, respectively). Here also it must be pointed out that contamination levels are those of unprocessed cereals and that a large part of the samples (46 out of 115) were taken during 2002, a year characterized by high levels of ZEA in harvested wheat (Pussemier *et al.* 2006b).

For the heavy metals, considering both farming systems, Table IV shows that the estimated average daily intake of the Belgian population with cereal products is 0.17 or 0.19 µg kg^{-1} bw for Cd. According to existing Belgian data (SCOOP 2004) the daily intake of Cd with cereals and cereal products is only 0.07 µg kg^{-1} bw. The large difference between these figures may be attributed to the fact that the present study is dealing with unprocessed cereals only. Anyway, the importance of cereals in the diet should not be underestimated regarding Cd intake since this group of foodstuffs can contribute to 28% of the total Cd intake in some countries like Germany and Belgium (SCOOP 2004).

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The estimated average daily Pb intake in Belgium is 37.9 µg per person or 0.57 µg kg^{-1} bw (SCOOP 2004). In this estimation, cereals were not considered (no data were available for Belgium). The Pb intake estimated in this study for conventional cereals (0.12 µg kg^{-1} bw) represents thus 17 % of the total daily intake (i.e. 0.69 µg kg^{-1} bw when considering cereals), which compares favourably with the percentage calculated for other countries such as France (17%) or Germany (13%).

The estimated average daily intake of Hg with cereal products is 0.6 and 0.7 ng kg^{-1} bw day^{-1}, whereas the average total daily intake of mercury is 40 ng Hg kg^{-1} bw (SCOOP 2004). Intake with fish represents a significant part of this value. The results of the present study indicate that the average daily intake with cereals and cereal products can contribute up to 1.75 % of the total daily intake. With high consumption (97.5th percentile), the intake rises to 0.34 - 0.37 µg kg^{-1} bw for Cd, 0.23 - 0.56 µg kg^{-1} bw for Pb and 1.3 ng kg^{-1} bw for Hg.

Table IV also shows the estimated intakes for the pesticides (only carried out for the conventionally produced cereals). In Table IV the estimated intakes are also expressed in % of the TDI or ADI, which makes it possible to make comparisons between chemicals belonging to the same group of contaminants (*i.e.* mycotoxins, environmental chemicals and pesticides) as well as between chemicals belonging to different classes of contaminants.

When comparing the two studied mycotoxins, it appears that DON is of higher risk for the consumers than ZEA. In addition, it is noteworthy to underline that large difference in mycotoxin contaminations can be observed from year to year as a result of varying climatic conditions (Pussemier *et al.* 2006b). Regarding the studied heavy metals, it appears that the risk associated with Cd is higher than with Pb and Hg. For pesticides, the exposure decreases in the following order: dichlorvos followed by pirimifos-methyl and by chlorpyrifos-methyl.

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The results of Table IV clearly indicate that, with an average consumption of cereals and cereal products, the consumer is mostly exposed to mycotoxins (in case of DON, 56-99 % of TDI in organic and conventional products, respectively). As in Belgium cereal consumption is widespread, the DON and ZEA contamination seems to be the most worrying for human health. Exposure to Cd (17 to 19 % of TDI) comes at the second position, while the group of pesticides occupies the third position with dichlorvos and pirimiphos-methyl (5 and 6 % of ADI in conventional products).

Considering all the contaminants together, it is noteworthy to mention that both conventional and organic modes of production are at risk. Organic production appears safer in terms of pesticides but mycotoxins and environmental contaminants are present in both systems and can sometimes be present at higher concentrations in organic products.

The Directorate-General "Health and Consumer Protection" and the European Food Safety Authority (EFSA) commissioned a survey to assess how people in the EU perceive risk, focusing in particular on food safety. The main finding is that people do not differentiate greatly between the various types of risks although they are more likely to worry about risks caused by external factors over which they have no control. At the top end of the “worry” scale, consumers express concern regarding external factors that are clearly identified as dangerous (pesticide residues, new viruses such as avian influenza, residues in meat, contamination of food by bacteria, unhygienic conditions outside home). In the midrange, one finds other external factors such as environmental pollutants (e.g. mercury), GMOs, food additives, animal welfare and bovine spongiform encephalopathy (European Commission 2006). By contrast, the present study indicates that in cereals certain natural and

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environmental contaminants, such as mycotoxins and heavy metals, are at higher risk than pesticides in long-term dietary intakes.

Conclusions

The present study makes it possible to compare the presence of several classes of contaminants in unprocessed cereals produced under conditions prevailing in Belgium in both the conventional and organic farming systems.

Contrasting with the risk perception by consumers, pesticides seem not to be the class of contaminants bearing the highest risk, as far as the potential exposure can be compared to the TDI. It is noteworthy, however, that post-harvest treatments in cereals, such as insecticide applications, may potentially present a significant risk (up to 20 % of the ADI for the highest consumers, not considering the effect of cereal processing) while field treatments seem to play a negligible role (very few residue detected, making it impossible to carry out a quantitative exposure analysis).

Mycotoxins that are not perceived as worrying by consumers can be present in both organic and conventional unprocessed cereals at levels that could potentially reach a significant portion or even exceed the TDI for average and high consumers, respectively. Environmental contaminants such as Cd and Pb can be present in unprocessed cereals whatever the farming system and the exposure via cereal product consumption can reach, respectively, one third or one sixth of the TDI for 97.5th percentile consumers.

As to the comparison between organic and conventional products, care should be taken when analysing the results. On the one hand, the most common pesticides (post-harvest insecticides) are regularly detected in conventional unprocessed cereals while they are not

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allowed in organic products. On the other hand, mycotoxins such as DON and ZEA are present in important amounts in both farming systems and Cd as well as Pb can be present in significant amounts too. Of course, this assessment is based on contaminant levels in unprocessed cereals and it is known that, after processing, the cereals (e.g. flour) will contain lower amounts of them. Still, one must be aware that more and more people give their preference to cereal products that are not or less processed (whole meal bread, for example) and, hence, it should be recommended to further assess the exposure towards these contaminants by considering cereal and cereal based products as they are found in the shelves of the stores by the consumers of conventional and organic foodstuffs.

Acknowledgements

This research was financed by the Belgian Federal Planning Service "Science Policy" (BELSPO), programme SPSD II, project CP-30 and CP-57. The Institute of Public Health, Department of Epidemiology (Dr H. Van Oeyen and Dr L Temme) are acknowledged for their kind help by providing cereal consumption data.

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Table I: DON and ZEA levels in cereals grown in Belgium during the years 2002-2005 (µg kg^{-1} fresh matter).

	DON			ZEA		
	Conventional	Organic	Total	Conventional	Organic	Total
n	65	52	117	68	47	115
mean	354	200	285	23.1	11.2	18.2
sd	500	225	407	49.6	21.4	40.8
median	220	137	151	0.75	0.75	0.75
P95	1278	706	1055	130	60.4	104
maximum	2842	1184	2842	232	86	232

n, number of samples; sd, standard deviation; P95, 95th percentile

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Table II: Cd, Pb and Hg levels in cereals grown in Belgium during the years 2002-2005 (µg kg^{-1} fresh matter).

	Cd			Pb			Hg		
	Conventional	Organic	Total	Conventional	Organic	Total	Conventional	Organic	Total
n	189	37	226	189	37	226	150	18	168
mean	61.7	66.8	62.5	42.1	100	51.7	0.24	0.22	0.23
sd	22.3	19.7	22.0	40	73.1	51.6	0.22	0.08	0.20
median	58.2	65.8	59.8	27.0	72.0	34.7	0.19	0.20	0.20
P95	98.4	106	102	109	280	155	0.48	0.40	0.46
maximum	188	117	188	287	328	328	2.44	0.45	2.44

n, number of samples; sd, standard deviation; P95, 95th percentile

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Table III: Pesticide levels in cereals grown in Belgium during the years 2002-2004 (µg kg^{-1} fresh matter).

	Chorpyriphos-Me			Dichlorvos			Pirimiphos-Me		
	Conventional	Organic	Total	Conventional	Organic	Total	Conventional	Organic	Total
n	106	0	106	106	0	106	106	0	106
mean	37.7	nd	37.7	70.8	nd	70.8	84.2	nd	84.2
sd	70.1	nd	70.1	304	nd	304	487	nd	487
median	25.0	nd	25.0	25.0	nd	25.0	25.7	nd	25.7
P95	176	nd	176	179	nd	179	192	nd	192
maximum	500	nd	500	2000	nd	2000	5000	nd	5000

n, number of samples ; sd, standard deviation; nd, no data; P95, 95th percentile

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Table IV: Daily intake estimates in µg kg^{-1} bw (and % of TDI/ADI)) for contaminants of cereal products (average contaminant levels considered; it is assumed that the levels of unprocessed cereals remain unchanged in consumed foodstuffs).

Contaminant	Organic			Conventional		
	Mean	Median	97.5th percentile	Mean	Median	97.5th percentile
DON	0.56 (56%)	0.53 (53%)	1.11 (111%)	0.99 (99%)	0.94 (94%)	1.97 (197%)
ZEA	0.03 (16%)	0.03 (15%)	0.06 (31%)	0.06 (33%)	0.06 (31%)	0.13 (64%)
Cd*	0.19 (19%)	0.17 (18%)	0.37 (37%)	0.17 (17%)	0.16 (16%)	0.34 (34%)
Pb*	0.28 (7.9%)	0.27 (7.4%)	0.56 (16%)	0.12 (3.3%)	0.11 (3.1%)	0.23 (6.6%)
Hg*	0.0006 (0.1%)	0.0006 (0.1%)	0.0013 (0.2%)	0.0007 (0.1%)	0.0006 (0.1%)	0.0013 (0.2%)
Chlorpyriphos-Me$	nd£	nd	nd	0.11 (1.1%)	0.10 (1.0%)	0.21 (2.1%)
Dichlorvos$	nd	nd	nd	0.20 (5.0%)	0.18 (4.8%)	0.39 (9.8%)
Pirimiphos-Me$	nd	nd	nd	0.24 (6.0%)	0.22 (5.5%)	0.47 (11.8%)

* TDI for heavy metals calculated as TWI/7

$ ADI for pesticides are 10 µg/kg bw (chlorpyriphos-Me) and 4 µg/kg bw (dichlorvos and pirimiphos-Me)

£ nd, no data

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