Intake of ochratoxin A and deoxynivalenol through beer consumption in Belgium

P. HARÇZ1, E. K. TANGNI1, O. WILMART2, E. MOONS2, C. VAN PETEGHEM3, S. DE SAEGER3, Y.-J. SCHNEIDER4, Y. LARONDELLE4, & L. PUSSEMIER1

1Veterinary and Agrochemical Research Centre (CODA-CERVA), Tervuren, Belgium, 2Federal Agency for the Safety of the Food Chain (FASFC), WTC III, Brussels, Belgium, 3Laboratory of Food Analysis, Faculty of Pharmaceutical Sciences, Ghent University, Gent, Belgium, and 4Université catholique de Louvain & Institut des Sciences de la Vie, Louvain-la-Neuve, Belgium

(Received 6 October 2006; revised 25 November 2006; accepted 4 December 2006)

Abstract
Estimations of ochratoxin A (OTA) and 4-deoxynivalenol (DON) exposure of the Belgian population through beer consumption were made using the results of the recent Belgian food survey and the compiled data set of OTA and DON levels in conventionally and organically produced beers in 2003–05. For the consumers of organic beers, the daily intake of OTA was 0.86 (in 2003), 1.76 (in 2004) and 0.72 (in 2005) ng kg\(^{-1}\) body weight (bw), considering the mean beer consumption (0.638 litres) and the average level of OTA in 2003, 2004 and 2005, respectively. Using the 97.5th percentile of beer consumption (1.972 litres), the corresponding OTA daily intakes were 2.65, 5.44 and 2.24 ng kg\(^{-1}\) bw, which are close or above the tolerable daily intake (TDI) of 5 ng kg\(^{-1}\) bw. For the consumers of conventional beers, the OTA intakes were low: 0.23, 0.23 and 0.11 ng kg\(^{-1}\) bw day\(^{-1}\) for the average beer consumption, in 2003, 2004 and 2005 against 0.72, 0.73 and 0.34 ng kg\(^{-1}\) bw day\(^{-1}\) when the 97.5th percentile level was considered. As for the DON intake, the estimates were quite low for both conventional and organic beer consumers when the provisional maximum TDI (PMTDI) of 1 \(\mu\)g kg\(^{-1}\) bw was considered. Average consumption of organic beer led to daily intakes of 0.05 and 0.04 \(\mu\)g DON kg\(^{-1}\) bw in 2003 and 2004, respectively, whilst for conventional beer, daily intakes were 0.07 and 0.05 \(\mu\)g DON kg\(^{-1}\) bw at the 97.5th percentile level of beer consumption, daily intakes of 0.15 and 0.13 \(\mu\)g kg\(^{-1}\) bw were obtained for organic beers against 0.23 and 0.17 \(\mu\)g kg\(^{-1}\) bw for conventional ones. The results showed that beer could be an important contributor to OTA exposure in Belgium, even though a declining trend seems to be apparent during the last year of monitoring. Therefore, efforts should be devoted to maintain the OTA levels as low as reasonably achievable, especially for organic beer.

Keywords: Intake, mycotoxins, ochratoxin A, deoxynivalenol, beer, organic, Belgium

Introduction
Cereals (Triticum aestivum and Hordeum vulgare) and derived products (flour, bread, pastry, and beer) are important commodities susceptible to contamination by mycotoxins. Their contamination by Fusarium mycotoxins such as nivalenol, deoxynivalenol (DON), 3-acetyl-DON, and 15-acetyl-DON starts in the field as a consequence of F. graminearum and F. culmorum attacks during flowering. Wet weather years are known to aggravate contamination by DON, one of the most important trichotheccenes of group B. Ochratoxin A (OTA) is another toxin produced by some Penicillium and Aspergillus species mainly during the storage of cereals. High moisture contents and a lack of hygienic measures (the presence of dust and moulded grains in the storage facilities) are known to be factors favouring contamination by OTA and other mycotoxins (Tangni and Pussemier 2006). The International Agency for Research on Cancer (IARC 1993) has classified OTA in Category 2B (possibly carcinogenic to humans) based on clearly carcinogenic effects in animals. OTA contamination will be more intense when the grains are not sufficiently dry.
Due to food crises in the past (e.g. bovine spongiform encephalopathy (BSE), the Belgian dioxin incident in 1999), organic food products have become more popular in Belgium and elsewhere (Pussemier et al. 2006). ‘Organic’ is a labelling term for products that have been obtained in accordance with organic standards throughout production, handling, processing and marketing stages, and certified by a duly constituted certification body or authority. For the general public, however, organic agriculture is often understood in a restricted sense, i.e. a farming system where synthetic pesticides and fertilizers are not authorized. The use of pesticides to reduce microbial contamination during cereal production and storage, as well as the addition of preservatives at different stages of foodstuff production and distribution, may lead to the presence of residues in the final products, which represent a possible threat for the safety of conventional products. In contrast, the non-use of pesticides or preservatives may result in increasing fungal contamination and, eventually, in increasing the amount of mycotoxins in the final products. Therefore, there is evidence that organic food often contains relatively high amounts of natural toxic compounds produced by fungi or plants, whereas corresponding conventional food tends to contain more synthetic compounds such as pesticide residues (Finamore et al. 2004; Pussemier et al. 2006). Moreover, the use of pesticides or preservatives in insufficient amounts could lead to an even worse situation since the stress imposed on the moulds is thought to stimulate mycotoxin production. In principle, although the foodstuffs resulting from conventional production are not free of mycotoxins, the organic foodstuffs may present in some circumstances a greater risk of contamination. Moreover, as there is a greater number of microorganism species able to develop during the organic production (in contrast to the conventional counterpart), a wider spectrum of mycotoxins may potentially be detected in the organic foodstuffs than in the conventional counterparts. Therefore, there is a need for information related to food safety, to inform consumers of the health benefits and/or hazards of food products of both origins, in order to optimize the impact on health and minimize the risks. Identification and quantitative assessment of mycotoxins present in specific raw materials, feed and foodstuffs, as well as in manufactured food, thus deserve further safety evaluation for public health concerns.

Exposure to mycotoxins in food is a widely recognized health risk that is receiving increasing attention (Bhat and Vasanthi 1999). Indeed, mycotoxins are associated with various acute and chronic diseases in domestic animals, livestock and humans in many parts of the world. They have various toxicological effects such as immunotoxicity, teratogenicity, mutagenicity and/or carcinogenicity in certain susceptible animal species and/or in humans. In recent years, thorough risk assessments of DON and of OTA established a provisional maximum tolerable daily intake (PMTDI) of 1 μg DON kg\(^{-1}\) body weight (bw) and a tolerable daily intake (TDI) of 5 ng OTA kg\(^{-1}\) bw (FAO/WHO 2001). Note that the European Food Safety Authority (EFSA) has recently proposed a new safety value of 120 ng OTA kg\(^{-1}\) bw as a tolerable weekly intake, which corresponds to a TDI of 17.1 ng kg\(^{-1}\) bw (EFSA 2006). This value is three times higher than the current TDI (FAO/WHO 2001).

DON and OTA are provided worldwide through beer consumption and it is suggested to include beer consumption in calculations of total exposure to DON and OTA, together with other sources of cereals and other foodstuffs, which undoubtedly provide these mycotoxins as well (Visconti et al. 2000; Tangni et al. 2002; Papadopoulou-Bouraoui et al. 2004; Anselme et al. 2006). Indeed, malting barley, wheat and corn, which are used in brewing, can be contaminated with OTA and/or DON. The maximum acceptable levels in malt are fixed at 750 μg DON kg\(^{-1}\) and 3 μg OTA kg\(^{-1}\) for malt and other processed cereals (EU 2001a, 2001b). These mycotoxins partially withstand the brewing, and finally remain present in beer (Niessen and Donhauser 1993; Baxter 1996; Baxter et al. 2001; Papadopoulou-Bouraoui et al. 2004). So far there is no proposed legal limit for DON in beer, whilst a maximum acceptable level was proposed at 200 ng OTA l\(^{-1}\) beer (FAO 2004).

In Belgium, Tangni et al. (2002) and Anselme et al. (2006) have conducted surveys on beers sold on the Belgian market and performed point estimations of OTA and DON intakes using a daily consumption of 0.3 litres beer per capita (CBB 2004). Note that the determination of this consumption was mainly based on the volume of manufactured, exported and imported beers in Belgian markets.

Food consumption data from a recent national food survey carried out in Belgium by the Institute of Public Health (Brussels) are now available. We therefore gathered data on OTA and DON in beers from surveys carried out in Belgium during 2003–05 and, by using the recent dietary survey, performed an assessment of the OTA and DON exposure of the Belgian population through the consumption of conventional or organic beer.
Materials and methods: Data input and statistical analysis

Database on food consumption in Belgium

Data from a 2004 food survey carried out in Belgium by the Institute of Public Health (Brussels) have been used to estimate intakes for the average population (beer consumers and no consumers altogether) (IPH 2006) as well as for the beer consumers only (L. Temme, personal communication). The 24-h recall method using EPIC-SOFT was used to perform the dietary survey over four different seasons from February 2004 to March 2005. For the beer consumer population, 765 subjects were interviewed with 1064 days of consumption, while for the entire population the survey was made with 3083 subjects older than 15 years old with 6166 days of consumption.

Databases of OTA and DON occurrence in beer

A large number of samples were included to ensure enough data for the risk assessment. DON and OTA databases from surveys performed by Anselme et al. (2006) and by the Federal Agency for the Safety of the Food Chain (FASFC). Thus, data collected from 2003 to 2004 on 42 conventionally produced beers and 33 organically produced beers purchased in supermarkets and retail shops were employed (Anselme et al. 2006). In addition, mycotoxin analysis results of 18 conventionally produced beers sampled in 2005 (nine for OTA and nine for DON) were also provided by FASFC. Finally, OTA contents in 18 additional samples (ten conventional and eight organic) in 2005 were also used (Anselme et al. 2006).

The mycotoxin contents are expressed in ng per litres of beer for OTA and μg per litres of beer for DON. The data of the results of mycotoxin analyses were treated as follows: for non-detects samples (value under the limit of detection, LOD), values were assumed to be 0.5 × LOD, while for trace levels (between the LOD and the limit of quantification, LOQ), values were assumed to be 0.5 × (LOD + LOQ) (Kroes et al. 2002). Data are reported as mean ± standard deviation (SD) and as percentiles.

Data handling and risk assessment

Intakes are estimated by multiplying beer consumption data either for the whole population or for the beer consumers by the average concentrations of mycotoxins present in the product. The use of average mycotoxin concentration in the intake calculations provides a realistic and appropriate estimation of the long-term exposure, since these intakes are compared with reference toxicological intake (TDI) (FAO/WHO 1997). Because of the numerous 'not quantified' and 'not detected' values and the mathematical assumptions made concerning these data, the values obtained with respect to risk quantification should be interpreted with caution.

The purpose of the risk assessment is to compare the intake determined for average, median, 97.5th and even 99th percentile levels of food consumption with the reference toxicological values established by the national, European or international scientific committees. The results obtained are thus expressed either as daily intakes in terms of ng OTA kg⁻¹ bw day⁻¹, μg DON kg⁻¹ bw day⁻¹ or as percentage of the TDI. Taking into account the different body weight values proposed in neighbouring countries (SCOOP 2002), the intake calculation was performed for an adult of 66 kg body weight.

Results and discussion

Beer consumption in Belgium

Beer consumption data for the total population as well as for the beer consumers are shown in Table I. This database integrates different levels of beer consumption such as average but also the 25th, 50th, 75th and 97.5th percentiles.

No significant regional variation between Flanders, on the one hand, and Brussels and Wallonia, on the other hand, was observed.

Table I. Weighed mean and percentiles of beer consumption (ml day⁻¹) for consumers only and for the total population (consumers and non-consumers) according to the region, sex, season and age of consumers in Belgium.

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>SD</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>P97.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>For consumers, during</td>
<td>637.9</td>
<td>499.1</td>
<td>312</td>
<td>482</td>
<td>787</td>
<td>1972</td>
</tr>
<tr>
<td>consumption days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total population, all days</td>
<td>122.1</td>
<td>228.6</td>
<td>0</td>
<td>162</td>
<td>778</td>
<td></td>
</tr>
<tr>
<td>Regional distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flanders</td>
<td>127.5</td>
<td>208.8</td>
<td>0</td>
<td>171</td>
<td>725</td>
<td></td>
</tr>
<tr>
<td>Brussels and Wallonia</td>
<td>110.9</td>
<td>185.8</td>
<td>0</td>
<td>163</td>
<td>626</td>
<td></td>
</tr>
<tr>
<td>Gender distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>36.8</td>
<td>79.1</td>
<td>0</td>
<td>39</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>215.3</td>
<td>294.2</td>
<td>0</td>
<td>111</td>
<td>1042</td>
<td></td>
</tr>
<tr>
<td>Seasonal distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>149.1</td>
<td>225.6</td>
<td>0</td>
<td>193</td>
<td>761</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>140.8</td>
<td>217.6</td>
<td>0</td>
<td>207</td>
<td>738</td>
<td></td>
</tr>
<tr>
<td>Autumn</td>
<td>107.9</td>
<td>179.3</td>
<td>0</td>
<td>155</td>
<td>626</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>77.2</td>
<td>134.4</td>
<td>0</td>
<td>104</td>
<td>459</td>
<td></td>
</tr>
<tr>
<td>Age distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;18 years</td>
<td>68.7</td>
<td>113.8</td>
<td>0</td>
<td>109</td>
<td>387</td>
<td></td>
</tr>
<tr>
<td>19–59 years</td>
<td>138.0</td>
<td>232.3</td>
<td>0</td>
<td>157</td>
<td>797</td>
<td></td>
</tr>
<tr>
<td>60–74 years</td>
<td>107.9</td>
<td>197.1</td>
<td>0</td>
<td>151</td>
<td>672</td>
<td></td>
</tr>
<tr>
<td>&gt;75 years</td>
<td>60.8</td>
<td>118.8</td>
<td>0</td>
<td>78</td>
<td>401</td>
<td></td>
</tr>
</tbody>
</table>

Sources: For the entire population, see http://www.iph.fgov.be/epidemio/; data for consumers only came from L. Temme, personal communication.
Beer consumption is prone to be higher for men than for women (215.3 versus 36.8 ml). Spring and summer periods are more favourable for beer drinking; while the high consumer’s ages ranged from 19 to 74 years.

**Occurrence of OTA and DON in beer**

Results of OTA and DON occurrence from the database gathered in Belgium are summarized in Tables II and III, respectively.

OTA presence in organically produced beer is significantly higher \((p < 0.0001)\) than in conventionally produced beers over 2003–05, even if a decreasing trend could be observed in 2005. Indeed, in 2005 the OTA levels were all below the limit of 200 ng l\(^{-1}\). As for the occurrence of DON, there is no significant difference between conventional and organic beers. It must be pointed out that a total of 102 samples (61 conventional and 41 organic) were analysed, which is rather low knowing that the total beer production in Belgium was 16 million hl in 2003 (CBB 2004).

**Intakes of OTA and DON through beer consumption**

Consumer exposure assessments to mycotoxins have traditionally relied on deterministic calculations. Using this approach, the results of the OTA and DON daily intakes estimated expressed in ng OTA kg\(^{-1}\) bw and in \(\mu\)g DON kg\(^{-1}\) bw are summarized in Tables IV and V, respectively.

For the consumers of conventional beer, the intake of OTA remains below 1 ng kg\(^{-1}\) bw, whatever the level of beer consumption throughout 2003–05 (Table IV). In contrast, for the consumers of organic beer, the OTA intake in 2003 was 66% of the TDI level at the 99th percentile of beer consumption (3.3 ng kg\(^{-1}\) bw), while in 2004, it exceeded the TDI at the 97.5th percentile of beer consumption (5.44 ng kg\(^{-1}\) bw) (Table IV). In 2005, the intake at the 99th percentile was 55.8% of the TDI (2.79 ng kg\(^{-1}\) bw).

As for the exposure to DON, the results presented in Table V show that the intakes remain low in all conditions throughout 2003–05. Even for high beer consumers (99th percentile), the intake reached a maximum of 0.29 and 0.21 \(\mu\)g kg\(^{-1}\) bw day\(^{-1}\) in 2003 and 2004, respectively. In 2005, the intake was 0.32 \(\mu\)g kg\(^{-1}\) bw day\(^{-1}\).

**Risk assessment**

In recent years, thorough risk assessments of OTA and DON established a TDI of 5 ng OTA kg\(^{-1}\) bw and a provisional maximum TDI (PMTDI) of 1 \(\mu\)g DON kg\(^{-1}\) bw (FAO/WHO 2001). These values are used in the present study.

**Average beer consumption and OTA and DON exposure.** Considering a mean daily intake of 0.638 litres beer per capita in Belgium (consumer population) and the mean level of
OTA found, beer consumption contributes to 1.11 ng OTA kg<sup>-1</sup> bw, which is equivalent to 22.2% of the TDI (for organically produced beer) or to 0.19 ng OTA kg<sup>-1</sup> bw, which is equivalent to 3.8% of the TDI (for conventionally produced beer).

Regarding DON, beer contributes to 0.045 mg DON kg<sup>-1</sup> bw, equivalent to 4.5% of PMTDI (for organically produced beer) or to 0.067 mg DON kg<sup>-1</sup> bw, equivalent to 6.7% of PMTDI (for conventionally produced beer) for an adult weighing 66 kg. Considering a mean daily intake of 0.122 litres beer per capita for the entire population, beer consumers’ intake is estimated at 4.2% or 0.7% of the OTA-TDI, considering organic or conventional beer consumption, respectively. As regards DON, the corresponding intakes are 0.9% (for organic beer) and 1.3% (for conventional beer) of the PMTDI. Note that the beer consumption for Belgium proposed by the Belgian Brewers Confederation (CBB 2004) is 0.3 litres per capita, which is higher than the mean consumption data provided by the recent official food survey. Accordingly, one could argue whether an average underestimation for the entire population may be presently performed.

Risk assessment for OTA. The OTA exposure through beer consumption can be high, especially when organically produced beers are chosen. The 97.5th percentile exposure is 5.44 ng OTA kg<sup>-1</sup> bw (equivalent TDI of 108.8%) for the beer consumer population and 2.14 ng OTA kg<sup>-1</sup> bw (equivalent TDI of 42.8%) for the entire population, by the consumption of organically produced beer. Within the Belgian population, the most endangered group is males aged 19–59 years, where the intake of OTA at 97.5th percentile exposure is

<table>
<thead>
<tr>
<th>Year</th>
<th>Conventional</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>0.23 (0.04)</td>
<td>0.86 (0.16)</td>
</tr>
<tr>
<td>2004</td>
<td>0.23 (0.04)</td>
<td>1.76 (0.33)</td>
</tr>
<tr>
<td>2005</td>
<td>0.11 (0.02)</td>
<td>0.72 (0.14)</td>
</tr>
</tbody>
</table>

*The first figure is for ‘consumers only’, whereas the figure in parentheses is for ‘all population’.

Risk assessment for DON. The results of DON intakes determined in this study show that Belgian beer consumption habits do not bear a risk of high DON intake whatever the beer consumption level, the year of monitoring and the organic route of production (organic versus conventional). Indeed, considering all years and mode of production together, the highest exposure for the beer consumer population is 0.26 μg DON kg<sup>-1</sup> bw (equivalent to 26% of PMTDI) at the 97.5th percentile of consumption and 0.32 μg DON kg<sup>-1</sup> bw (equivalent to 32% of PMTDI) at the 99th percentile of consumption (Table V). Anselme et al. (2006) already concluded from the analysis of a more limited data set that DON contamination in Belgian beers should not be a major matter of concern, but care should taken to maintain this low level.
Table VI. OTA intake with average beer (only conventional) consumption in a few European countries compared with the Belgian data.

<table>
<thead>
<tr>
<th>Country</th>
<th>Average* beer consumption (ml day⁻¹)</th>
<th>OTA average* intake with beer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ng kg⁻¹ bw day⁻¹</td>
</tr>
<tr>
<td>Denmark</td>
<td>203.8 (-)</td>
<td>0.14 (-)</td>
</tr>
<tr>
<td>Finland</td>
<td>230 (-)</td>
<td>0.12 (-)</td>
</tr>
<tr>
<td>Italy</td>
<td>110.83 (23.03)</td>
<td>0.03 (0.01)</td>
</tr>
<tr>
<td>Portugal</td>
<td>–(177.3)</td>
<td>–(0.01)</td>
</tr>
<tr>
<td>Belgium</td>
<td>637.9 (122.1)</td>
<td>0.19 (0.03)</td>
</tr>
</tbody>
</table>

*The first figure is for ‘Consumers only’, whereas the figure in parentheses is for ‘all population’. (-), Data missing.

2.20 ng OTA kg⁻¹ bw (44% of the TDI) in 2004, with organic beer consumption.

Tangni et al. (2002) and Anselme et al. (2006) conducted surveys on beers found on the Belgian market. From these studies, it appears that the level of OTA contamination is very variable either in the organic or in the conventional brands, but in both studies the contamination tends to be higher for organic beers. The situation improved from 2003–04 to 2005 since maximum levels have been newly imposed on malt (EC Nos 466/2001 and 856/2005; EC 2001a, 2001b) but the number of analysed samples is quite low for 2005 and additional efforts should be devoted to continue the monitoring of organic and conventional beers.

Table VI allows a comparison of OTA intakes linked to average beer consumption in several European countries.

Note that only conventional beer is considered because of its worldwide production and consumption, whilst organic beer is quite marginal and data on organic beer contamination are scarce. As can be seen from the data, the average OTA intake with beer is quite higher in Belgium due to higher average consumption habits (SCOOP 2002; FPS Economy — Directorate-General Statistics Belgium 2003). However, this average intake still remains below 5% of the TDI. Taking into account the beer consumers at higher percentiles, intakes will reach, for some part of the population, much higher values, exceeding in some cases the TDI that has been set considering all foodstuffs together. There is thus a need to lower as much as possible the OTA levels in beer taking into account the consumption habits in Belgium.

The limit of 200 ng OTA⁻¹ in beer has been proposed (EC 1998; FAO 2004). Applying this proposed level to the Belgian food consumption data, the result shows that the mean exposure for the total population would be 0.37 ng OTA kg⁻¹ bw (7.4% of the TDI), whereas the 97.5th percentile exposure of the total population reaches 2.36 ng OTA kg⁻¹ bw (47.2% of the TDI). Considering the consumers only, mean consumption contributes to an exposure of 1.93 ng OTA kg⁻¹ bw (38.6% of the TDI) and with high consumption (97.5th percentile) it will reach 5.97 ng OTA kg⁻¹ bw, which clearly exceeds the TDI (119.5%). Thus, taking into account the Belgian beer consumption habits, a 200 ng OTA⁻¹ concentration can be a risk for consumers. Note that beer is not the only foodstuff contributing to OTA exposure. Cereals and cereal products, coffee, wine, cocoa-derived products, dried fruits, and spices can also contain significant amounts of OTA (SCOOP 2002).

In the light of the above results, beer derived from locally produced or imported cereals can be contaminated by DON, a field-produced mycotoxin, as well as OTA, a typical storage mycotoxin, which can be produced by moulds in high amounts under conditions prevailing in Belgium and elsewhere (Tangni and Pussemier 2006). So far, the occurrence of DON in beer has not been considered a major cause for concern since its contamination levels are very low. In contrast, there is a risk of exposure to a significant amount of OTA with respect to the TDI. The risk seems to be significantly higher for consumers of organic beer. Limited data available so far seem to indicate a recent reduction of OTA contamination, probably as a consequence of the implementation of European Union Regulation Nos 466/2001 and 856/2005 (EU 2001a, 2001b) that limit OTA in malt to a maximum content of 3 μg kg⁻¹. Nevertheless, since it appears that a limit of 200 ng OTA⁻¹ would not allow a satisfactory level of protection for the high consumers, the question is raised whether more stringent regulations should apply to beer in Belgium as well as in other countries with high beer consumption habits such as the Czech Republic, the UK, Germany, Ireland, Austria and Denmark.

Obviously, there is thus a need to increase the monitoring of beers by taking into account the numerous factors able to influence the contamination and the large variability due to the high number of brands and brewing processes existing in some specific countries such as Belgium (CBB 2004). In addition, a probabilistic assessment of the OTA intake by the Belgian population should be carried...
out, taking into account the regional, seasonal, gender and age-specific habits of beer consumption as well as all the other dietary sources of OTA intake.

Acknowledgements
This research was financed by the Belgian Federal Planning Service ‘Science Policy’ (BELSPO), Programme SPSD II, Project Nos CP-30 and CP-57. Drs H. Van Oyen and L. Temme of the Department of Epidemiology (Institute of Public Health) are acknowledged for their kind help by providing additional beer consumption data.

References


