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The New Zealand Mycotoxin Surveillance Program 06-14 Report Series

FW11075 Ochratoxin A in Cereals, Wine, Beer and Coffee

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Scientific Interpretive Summary

This SIS is prepared by MPI risk assessors to provide context to the following report for MPI risk managers and external readers

The New Zealand Mycotoxin Surveillance Program 06-14 Report Series

FW11075 Ochratoxin A in Cereals, Wine, Beer and Coffee

These reports are the outputs of MPIs ongoing mycotoxin surveillance programme. The nine reports form a series detailing the research undertaken over the last eight years to characterise and quantify the risk to the New Zealand public through the presence of mycotoxins in the food supply.

The nine reports are:

- Risk Profile: Mycotoxin in Foods 2006
- Aflatoxins in Maize Products 2008
- Aflatoxins and Ochratoxin A in Dried Fruits and Spices 2009
- Aflatoxins in Nuts and Nut Products 2010
- Dietary Exposure to Aflatoxins 2011
- Ochratoxin A in Cereal Products, Wine, Beer and Coffee 2011
- Trichothecene Mycotoxins in Cereal Products 2014
- Dietary Exposure to Ochratoxin A and Trichothecene Mycotoxins 2014
- Risk Profile: Mycotoxin in Foods 2014

Ochratoxin A in Cereal Products, Wine, Beer and Coffee 2011

Ochratoxin A (OTA) was listed as the 2nd priority in the 2006 mycotoxins risk profile for which to generate occurrence data in the New Zealand diet.

The report details the selection of samples from the 2009 TDS retention samples and the analytical methodology utilised to detect OTA.

The detail on the analytical methodology and quality control checks utilised indicates that the results can be viewed with strong confidence.

OTA was present in 22 out of the 208 samples analysed with bran flakes and muesli having the most frequent detections and highest reported levels. The levels were consistent with those previously reported in New Zealand. Only four of the results were above the quantification limit with the rest being indicative values between the quantification and detection limit.

Levels of OTA where comparable data was available were consistent or lower to those reported overseas.

MYCOTOXIN SURVEILLANCE PROGRAMME 2011
OCHRATOXIN A IN CEREAL PRODUCTS, WINE, BEER AND COFFEE

Report Number FW11075

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MYCOTOXIN SURVEILLANCE PROGRAMME 2011
OCHRATOXIN A IN CEREAL PRODUCTS, WINE, BEER AND COFFEE

Prepared for Ministry of Agriculture and Forestry
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Client Report FW11075

by

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October 2011

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SUMMARY

The Mycotoxin Surveillance Programme (MSP) involves investigation of food safety issues associated with mycotoxins in the New Zealand food supply, as identified in a risk profiling exercise carried out in 2005-2006. During 2011, the MSP continued analysis of the presence of ochratoxin A (OTA) in foods likely to contribute to dietary exposure to OTA (cereal products, wine, beer and coffee). Analyses were carried out on retained samples from the 2009 New Zealand Total Diet Survey.

OTA was detected in 22 of 208 samples (10.6%) analysed in the current survey. The samples were made up of cereal products (168), wine (16), beer (8) and coffee (16). OTA was most frequently detected in bran flake cereal (4 of 8 samples) and in muesli (3 of 8 samples). These were also the food types containing the highest individual concentrations of OTA. Concentrations of OTA found in New Zealand foods were mostly very low, with only 4 results being above the analytical limit of quantitation (LOQ). The remaining 18 detected results were at levels between the limit of detection (LOD) and LOQ and have been presented in this report as indicative concentrations.

While the Australia New Zealand Food Standards Code does not contain regulatory limits for OTA, the concentrations of OTA found in the current study would have been compliant with regulatory limits promulgated in other countries for OTA.

Dietary exposure estimates for OTA, considering all potential food sources, would assist in placing the results of the current survey in context with respect to human health risks.

1 INTRODUCTION

The Mycotoxin Surveillance Programme (MSP) involves investigation of food safety issues associated with mycotoxins in the New Zealand food supply.

As with other activities of the Ministry of Agriculture and Forestry (MAF), activities in this area are directed on the basis of risk. The risk profile of mycotoxins in the New Zealand food supply (Cressey and Thomson, 2006) is viewed as a starting point for this process. The risk profile identified a number of issues to be investigated or clarified.

Effort in previous years have focussed on determination of aflatoxins in a range of foods (Cressey and Jones, 2008; 2009; 2010), culminating in a dietary exposure assessment (Cressey, 2011), and analysis of ochratoxin A (OTA) in dried fruits and spices (Cressey and Jones, 2009). During 2011, the MSP continued analysis of the presence of OTA in foods.

1.1 Ochratoxin A

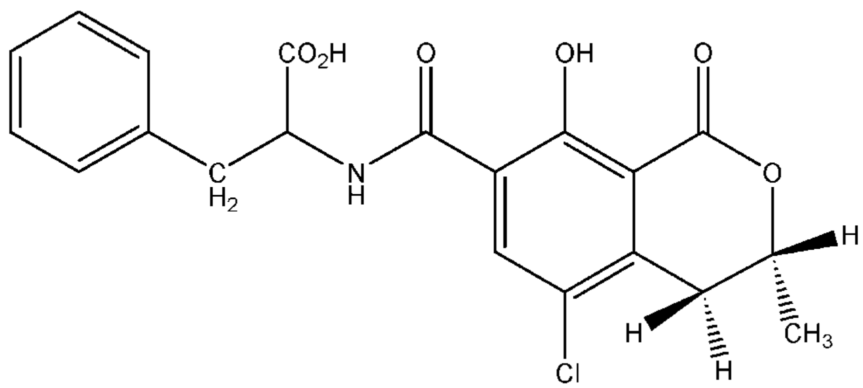
1.1.1 <u>Hazard identification</u>

OTA is produced by *Aspergillus ochraceus* and a related *Aspergillus* species, *A. carbonarius,* as well as some isolates of *A. niger*, and by *Penicillium verrucosum* (Joint FAO/WHO Expert Committee on Food Additives, 2001). These organisms differ in their geographical distribution and ecological niche, in the commodities affected, and the point at which they are likely to infect commodities.

1.1.1.1 Structure and nomenclature

OTA contains a chlorinated isocoumarin moiety linked via a carboxyl group to L-phenylalanine. Ochratoxin B (a dechlorinated analogue of OTA) and ochratoxin C (an ethyl ester of OTA) have also been detected, but OTA is by far the major ochratoxin found in crop plants (Walker, 1999).

Figure 1: Structure of ochratoxin A



1.1.1.2 Occurrence

P. verrucosum is a cool climate organism (0-31˚C, optimum 20˚C), occurring only in cool temperate regions, and is able to grow at water activities as low as 0.8 (Pitt and Hocking, 1997). It is the source of OTA formation in stored cereals and cereal products in European countries and Canada. Due to the high stability of OTA, this can also result in the presence of OTA in animals fed contaminated cereals. *P. verrucosum* does not occur in the tropics (Joint FAO/WHO Expert Committee on Food Additives, 2001).

A. ochraceus grows at moderate temperatures (8-37˚C, optimum 24-31˚C) and at water activities above 0.8 (optimum 0.95-0.99) (Pitt and Hocking, 1997). It occurs occasionally on a wide range of stored food products, but is seldom the cause of substantial concentrations of OTA (Joint FAO/WHO Expert Committee on Food Additives, 2001).

A. carbonarius grows at high temperatures (max 40˚C, optimum 32-35˚C) and is associated with maturing fruit, particularly grapes. It is the major source of OTA in fresh grapes, dried vine fruits and wine (Joint FAO/WHO Expert Committee on Food Additives, 2001).

OTA contamination is principally found in cereals, but can also occur in coffee, cocoa, spices, nuts, dried vine fruits, grape juice and wine, beer, and pork and pork products made from animals fed OTA contaminated feed (Walker, 1999).

Sayer and Lauren did not report isolation of any of these OTA-forming fungal species from New Zealand grain sampled at harvest (Sayer and Lauren, 1991). No information was found on occurrence of these fungal species on stored grain in New Zealand. Similarly, no information was found on *Aspergillus* infection of grapes or other fruits in New Zealand. However, it has been noted that bunch rot of vines due to *A. niger* probably occurs in New Zealand, but hasn't been officially reported[1].

1.2 Previous Ochratoxin A Surveillance in New Zealand

A survey for OTA was carried out in 2000 (Stanton, 2000), with OTA detected in breakfast cereals (6/22), cereals (10/26), pulses (2/14), coffee/milo/cocoa (17/24), dried fruit (16/35) and wine (2/17).

Unpublished work carried out by ESR in 2007 found OTA in bread (5/12), breakfast cereals (7/23), coffee (7/8), dried fruit (3/10) and spices (15/17) (Darren Saunders, ESR, personal communication).

A survey, carried out under the MSP, detected OTA in dried fruit (5/40) and spices (22/30) (Cressey and Jones, 2009).

[1] http://www.hortnet.co.nz/publications/hortfacts/hf905020.htm

1.3 Foods Contributing to Ochratoxin A Exposure Overseas

The French Total Diet Study estimated that 61% of adult OTA exposure was due to consumption of cereals and cereal products (bread, breakfast cereals, pasta, rice and semolina, biscuits, cakes) (Leblanc *et al.*, 2005). A Canadian assessment estimated a similar proportion of adult exposure as due to cereal consumption (69%), followed by coffee (9%), pork (9%), beer (8%) and raisins (2%) (Kuiper-Goodman *et al.*, 2010). A Spanish study estimated a slightly lower average contribution from cereals (46%) and a greater contribution from wine (26%) and dried fruit (14%) (Coronel *et al.*, 2009). A Codex assessment, based on European data, concluded that 54% of dietary exposure was due to cereal consumption, followed by red wine (15%), coffee (12%) and beer (8%) (Codex Committee on Food Additives and Contaminants, 1998). Scenarios based on French and Italian diets have estimated wine as the major source of OTA exposure, followed by cereals (Panel on Contaminants in the Food Chain, 2006). A global assessment conducted by the Joint FAO/WHO Committee on Food Additives (JECFA) concluded that the major contributor to OTA exposure was cereal consumption, followed by wine and coffee (Joint FAO/WHO Expert Committee on Food Additives, 2001).

2 MATERIALS AND METHODS

2.1 Foods Sampled

An initial scoping exercise identified cereals and cereal products, wine, beer and coffee as foods commonly contaminated with OTA that had not previously been analysed under the MSP.

After consideration of options, it was decided to use stored samples from the 2009 New Zealand Total Diet Study (NZTDS)[2]. These samples constitute a national representative 'snap-shot' of foods consumed in New Zealand at a particular point in time. Foods selected for OTA analysis are given in Table 1.

Table 1: New Zealand Total Diet Survey (NZTDS) sample types and sample numbers relevant to ochratoxin A analyses

Food Category	Food	Number of samples available
Cereals and cereal products	Bread, mixed grain	8
	Bread, wheatmeal	8
	Bread, white	8
	Biscuits, chocolate	8
	Biscuits, cracker	8
	Biscuits, sweet plain	8
	Cornflakes	8
	Bran flake cereal	8
	Wheat biscuit cereal	8
	Muesli	8
	Oats, rolled	8
	Cake, plain	8
	Muffin	8
	Noodles, instant (cooked)	8
	Pasta, dried (cooked)	8
	Rice, white (cooked)	8
	Spaghetti in sauce, canned	8
	Snack bars	8
	Snacks, flavoured	8
	Pizza	8
	Infant weaning food, cereal-based	8
Coffee	Coffee, brewed[1]	8
	Coffee, instant	8
Wine	Wine, still red	8
	Wine, still white	8
Beer	Beer	8
Total		**208**

[1] From ground beans

[2] http://www.foodsafety.govt.nz/science/research-projects/total-diet-survey/

Foods were classified as either:

- National (N) foods, which were not expected to exhibit any regional variability and included processed foods, such as biscuits, breakfast cereals and beverages (wine, beer), which are uniformly available throughout New Zealand. National Foods were sampled in a single location (Christchurch) over five weeks on two separate occasions (January/February 2009 and July/August 2009). Multiple purchases (up to 10) of four leading brands, selected on the basis of market share, were collected on each sampling occasion. Foods were analysed on the basis of composites of individual brands per season to give a total of four analyses for each food for each of the two seasons.

- Regional (R) foods that may be expected to demonstrate variation in contaminant level depending on the location in which the food was produced. Regional foods include bread, muffins, and brewed coffee. Regional foods were sampled in each of four locations (Auckland, Napier, Christchurch and Dunedin) over six weeks on two separate occasions (April/May 2009 and October/November/December 2009). Multiple purchases of each food (up to 20) were made in each region, from at least two different outlets, such as supermarkets and specialty shops (for example, supermarket, bakery). Foods were prepared and analysed on the basis of composites of individual regions/season to give a total of four analyses for each food for each of the two seasons.

Use of NZTDS food samples has a number of advantages. They are:
- sampled to be nationally representative. This avoids duplication of sampling and sampling costs.
- homogenised. This avoids further sample preparation costs.
- within a similar sampling timeframe to other samples on which OTA analyses have been performed (dried fruit and spices) (Cressey and Jones, 2009).
- processed foods and so the inhomogeneous nature of mycotoxin contamination in commodities is less likely to be a problem (Joint FAO/WHO Expert Committee on Food Additives, 2001).

All foods in the 2009 NZTDS had eight different composite samples analysed. Foods were also prepared ‘as consumed’. For the majority of foods included in the current survey, foods are consumed as they are purchased (for example, bread). For foods such as dry pasta and instant coffee, NZTDS samples were subjected to a preparation step prior to analysis. For example, instant coffee was prepared with boiling water. These food preparation steps will often decrease the apparent concentration of OTA in the foods, sometimes to undetectable levels. This loss of detectablility must be balanced against the greater relevance of prepared foods to human dietary exposure.

The use of composite samples for analysis may ‘dilute’ occasional individual samples containing elevated concentrations of OTA. However, this is consistent with the chronic nature of health concerns relating to OTA (Joint FAO/WHO Expert Committee on Food Additives, 2001); risk is related to the long-term average level of exposure, rather than occasional peak levels of exposure.

The NZTDS food samples have been in frozen storage for up to two years. OTA is a particularly stable molecule and is not destroyed by common food preparation procedures (Panel on Contaminants in the Food Chain, 2006). Heating to temperatures over 250ºC for several minutes is required to reduce the OTA concentration in foods (Panel on Contaminants in the Food Chain, 2006) and 700 minutes of heating at 100ºC is necessary to achieve a 50% reduction in OTA concentrations (Joint FAO/WHO Expert Committee on Food Additives, 2001). While specific information on stability under frozen storage was not identified, scientific literature on OTA analysis universally describes frozen storage of food samples (-18 to -20ºC) when there is a time period between sampling and analysis (Jørgensen, 1998; Jurjevic *et al.*, 1999; MacDonald *et al.*, 1999; Food Standards Agency, 2002a; Jørgensen and Petersen, 2002; Stefanaki *et al.*, 2003; Lombaert *et al.*, 2004; Food Standards Agency, 2005b; Iamanaka *et al.*, 2005; Juan *et al.*, 2007; Karbancioglu-Güler and Heperkan, 2008; Villa and Markaki, 2009; Duarte *et al.*, 2010; Food Standards Agency, 2010; Rubert *et al.*, 2010). While the period of frozen storage is usually not specified in these references, storage periods of up to two years could be inferred in some cases.

Analysis of frozen samples is consistent with normal analytical practices for OTA. There is no indication that the length of frozen storage could be a factor.

2.2 Analytical Methodology

2.2.1 Ochratoxin A

Extraction and clean up was based on Association of Official Analytical Chemists (AOAC) Standard Method 49.6.02A (2005) and the method of Lobeau *et al*. (Lobeau *et al.*, 2007).

Samples (15 g) were blended with 150 ml of methanol-3% aqueous sodium bicarbonate (80:20) for one minute, then filtered (Whatman No. 4). Filtrate (10 ml) was diluted with 40 ml of phosphate buffered saline (PBS) containing Tween 20 (0.01%) and applied to an Ochratest immunoaffinity column (Vicam, Watertown, USA). The column was washed with water (2 x 5 ml) and allowed to dry before ochratoxin A was eluted with methanol (4 x 1 ml). Solvent was removed under reduced pressure and the extract was redissolved in 1 ml 60% acetonitrile-39% water-1% acetic acid (Mobile phase B).

HPLC was carried out on a C18 reversed-phase column at a flow rate of 1.5 ml/min using an isocratic mixture of 65% mobile phase A (20% acetonitrile-15% methanol-64% water-1% acetic acid) and 35% mobile phase B. Injection volume was 50 µL. Detection was by fluorescence with excitation wavelength 333 nm and emission wavelength of 460 nm.

2.2.2 Analytical quality control

Four quality control materials (FAPAS – Food Analysis Performance Assessment Scheme, operated by the Food and Environment Research Agency, Sand Hutton, York, United Kingdom) were analysed for OTA. The materials were:

- T1782 Cereal-based baby food
- T1784 Instant coffee
- T1795 Wine

- T1796 Wheat flour

Results of the analyses are shown in Table 2.

Table 2: Analysis of quality control materials

QC Material	Ochratoxin A concentration (µg/kg)		
	Assigned value	Satisfactory range	ESR analytical results
T1782 Cereal-based baby food	0.33	0.19-0.48	0.33, 0.31
T1784 Instant coffee	5.39	3.02-7.76	3.49, 3.50
T1795 Wine	1.23	0.69-1.77	1.01, 1.15
T1796 Wheat flour	2.10	1.18-3.03	1.84, 1.92

Ochratoxin A (Sigma-Aldrich, from *A. ochraceus*, analytical standard grade) was prepared as a 1,000 µg/kg solution in mobile phase B (see section 2.2.1) and spiked into samples of each of the solid matrices examined at a concentration of 2 or 4 µg/kg, or into the liquid matrices at concentrations of 0.1, 1 or 2 µg/kg. Samples were analysed with and without the addition of the OTA spike, with recovery determined as the difference between these results, expressed as a percentage of added OTA. Mean recoveries are reported in Table 3.

Table 3: Spike recoveries for ochratoxin A in cereals and cereal products, wine, beer and coffee

Food	Ochratoxin A mean spike recovery (%)
Cornflakes	96
Muesli	97
Biscuits, cracker	94
Pasta, cooked	89
Bread, white	99
Biscuits, chocolate	99
Muffin	97
Biscuits, plain sweet	91
Bran flake cereal	97
Noodles, instant (cooked)	84
Snack bars	94
Snack, flavoured	93
Infant weaning food, cereal based	69
Rice, white (cooked)	87
Oats, rolled	78
Spaghetti in sauce, canned	85
Pizza	82
Wheat biscuit cereal	85
Wine, white	81 (1.0 µg/L) 88 (0.1 µg/L)
Wine, red	80 (1.0 µg/L)

Food	Ochratoxin A mean spike recovery (%)
Beer	80 (0.1 µg/L) 64 (1.0 µg/L) 76 (0.1 µg/L)
Coffee, instant	70 (2.0 µg/L) 64 (1.0 µg/L) 83 (0.1 µg/L)

The spike recoveries were generally within the range considered to be acceptable for trace analysis (70-120%). It should be noted that for beer and instant coffee recoveries were superior at lower spike levels, at concentrations typical of OTA in these food types. All analytical results were reported without correction for recovery.

The coefficient of variation (CV), based on analysis of duplicate samples, was 4.8%.

Limits of detection (LOD) and quantitation (LOQ) were calculated as the concentrations equivalent to a signal three and ten times the average background noise (S/N ratios) (United States Food and Drug Administration, 1996), taking into account the volume of sample used for analysis. LODs and LOQs are summarised in Table 4.

Table 4: Limits of detection (LOD) and limits of quantitation (LOQ) for ochratoxin A analyses

Matrix type	LOD (µg/kg or µg/L)	LOQ (µg/kg or µg/L)
Solid samples	0.2	0.7
Liquid samples	0.05	0.17

Results falling between the LOD and the LOQ were termed 'indicative'. These appear in this report as quantitative values in brackets. For solid samples, LODs in the range 0.01-0.6 µg/kg have been reported in the literature (see Appendix 2, Table A2.1 for a list of relevant studies). For liquid samples, literature LODs have been reported in the range 0.0005-0.08 µg/L.

3 RESULTS AND DISCUSSION

3.1 Summary of Results

Results for the foods analysed in the current study are summarised in Table 5. Full details of results are given in Appendix 1, Table A1.1.

Table 5: Ochratoxin A content of cereals, wine, beer and coffee available on the New Zealand market

Food type	Number of samples	Number positive for OTA (%)		OTA in positive samples (µg/kg)*
Bread, mixed grain	8	3	(38%)	(0.30)-(0.41)
Bread, wheatmeal	8	2	(25%)	(0.45)-(0.52)
Bread, white	8	2	(25%)	(0.40)-(0.55)
Biscuits, chocolate	8	0	(0%)	
Biscuits, cracker	8	0	(0%)	
Biscuits, sweet plain	8	2	(25%)	(0.20)-(0.42)
Cornflakes	8	0	(0%)	
Bran flake cereal	8	4	(50%)	(0.20)-2.99
Wheat biscuit cereal	8	0	(0%)	
Muesli	8	3	(38%)	(0.24)-1.42
Oats, rolled	8	0	(0%)	
Cake, plain	8	0	(0%)	
Muffin	8	1	(13%)	(0.33)
Noodles, instant (cooked)	8	1	(13%)	0.79
Pasta, dried (cooked)	8	1	(13%)	(0.52)
Rice, white (cooked)	8	0	(0%)	
Spaghetti in sauce, canned	8	0	(0%)	
Snack bars	8	2	(25%)	(0.21)-(0.30)
Snacks, flavoured	8	0	(0%)	
Pizza	8	0	(0%)	
Infant weaning food, cereal based	8	0	(0%)	
Coffee, brewed	8	1	(13%)	(0.09)
Coffee, instant	8	0	(0%)	
Wine, still red	8	0	(0%)	
Wine, still white	8	0	(0%)	
Beer	8	0	(0%)	

* Concentration figures in brackets are indicative and relate to analytical results that were above the limit of detection, but below the limit of quantitation

3.2 Ochratoxin A in Individual Food Types

When OTA was present in survey foods, the mycotoxin was usually present at low concentrations, usually between the LOD and LOQ.

3.2.1 Bread

Three types of bread were analysed for OTA in the current survey (mixed grain, wheatmeal, white). Bread type did not appear to have much influence on the OTA content of bread, with all three bread types exhibiting a similar prevalence of OTA contamination (25-38%) and similar concentrations, in the range 0.3-0.5 μg/kg.

Little other information is available on the OTA content of New Zealand bread. An unpublished New Zealand study found OTA in 1/12 (8%) bread samples at concentrations greater than 0.2 μg/kg (D. Saunders, ESR, personal communication).

Overseas studies vary considerably in the prevalence of OTA found in bread (10-70%) (Appendix 2, Table A2.1). The maximum concentrations of OTA found in bread in the current study (0.55 μg/kg) appear to be markedly lower than maximum concentrations found overseas (0.8-149 μg/kg), although the compositing used in the NZTDS may have 'diluted' samples containing high concentrations of OTA.

3.2.2 Biscuits

Three types of biscuits were analysed for OTA in the current survey (plain, chocolate-coated, cracker). OTA was only detected in plain sweet biscuit. The prevalence of OTA in plain sweet biscuits was 25%, while the overall prevalence in all biscuit types was 8%.

No previous information on the OTA content of New Zealand biscuits was found and none of the overseas studies reviewed specifically refer to biscuits.

3.2.3 Breakfast cereals

Five types of breakfast cereal were analysed for OTA in the current study (cornflakes, bran flake cereal, wheat biscuit cereal, muesli and rolled oats. The highest prevalence (50%) and highest OTA concentration 2.99 μg/kg were found in bran flake cereal. This is not surprising, as the bran is the exterior layer of the grain and the first point where fungal infection occurs.

The overall prevalence of OTA in breakfast cereals (7/40; 18%) was similar to the prevalence of 22% found in an earlier (2007) unpublished New Zealand study (D. Saunders, ESR, personal communication). The maximum OTA concentration found in breakfast cereals in the earlier study (2.85 μg/kg) was also similar to the current study.

Overseas studies vary considerably in the prevalence of OTA found in bread (10-90%) (Appendix 2, Table A2.1).

3.2.4 Bakery products

Two types of bakery product were included in the current survey (muffins and cake). Only one muffin sample (6% of all bakery products) contained detectable concentrations of OTA.

No comparative New Zealand or overseas information was found for similar products.

3.2.5 Pasta and noodles

Three types of pasta or noodles were included in the current survey (instant noodles, pasta cooked from dried and canned spaghetti in sauce). OTA was detected in one sample of instant noodles and one sample of pasta cooked from dry (8% of all pasta and noodle samples). The highest concentration of OTA was found in instant noodles (0.79 μg/kg). Given that spices are known to be frequently contaminated with OTA (Cressey and Jones, 2009), the instant noodle flavouring may have contributed to the OTA measured.

No comparative New Zealand information was found for similar products.

Overseas studies found higher prevalence and concentrations of OTA in dried pasta and noodles (Appendix 2, Table A2.1), but no comparative information was found for cooked pasta and noodles.

3.2.6 Other cereal products

OTA was not detected in any rice sample in the current survey. This is consistent with an earlier New Zealand survey (Stanton, 2000). However, overseas studies have found OTA in 0-100% of rice samples analysed and no conclusions about the 'typical' prevalence of OTA contamination in rice can be made.

OTA was detected in 25% of snack bar samples analysed. Given the range of potentially-OTA contaminated ingredients that may be present in snack bars (cereals, nuts, dried fruit), this is not a surprising result. No comparative data were found for this product type.

OTA was not detected in any sample of extruded flavoured snacks. No other New Zealand information on OTA in these products was found. A British study of mycotoxins in maize-based foods did not detect OTA in extruded flavoured snacks (Food Standards Agency, 2005a).

OTA was not detected in any pizza sample analysed. No comparative New Zealand or overseas information was found for similar products.

OTA was not detected in any sample of cereal-based infant food. While these foods have not previously been analysed for OTA in New Zealand, prevalence of OTA in these products of up to 70% has been reported overseas (Appendix 2, Table A2.1).

3.2.7 Wine

OTA was not detected in any of the composite samples of white or red wine analysed in the current survey above the LOD of 0.05 μg/L. A previous New Zealand study did not detect OTA in any of 6 white wine samples, but detected OTA in 2 of 9 red wine samples at concentrations of 0.03 and 0.68 μg/L (Stanton, 2000).

It is difficult to compare the results of the current survey to other studies of OTA in wine from the scientific literature (Appendix 2, Table A2.1), due to differences in the LOD. For example, a Spanish study found OTA in 100% of 20 red wine samples, but the maximum concentration detected was 0.04 µg/kg. This is less than the LOD in the current study. Maximum OTA concentrations in the range 0.2-3.0 µg/kg have seen commonly reported in overseas studies, but concentrations of this magnitude were not seen in New Zealand wine samples. However, the analysis of composite samples means that occasional high concentrations of OTA in individual wine samples are unlikely to have been detected.

3.2.8 Beer

OTA was not detected in any of the composite samples of beer analysed in the current study above the LOD of 0.05 µg/L. A previous New Zealand study did not detect OTA in a single sample of beer above the LOD of 0.02 µg/L (Stanton, 2000).

The prevalence of OTA in beer varies considerably between different overseas studies; from 0 to 100% (Appendix 2, Table A2.1). In part, this is due to the very low LODs achieved in some studies. Overseas studies commonly report maximum OTA concentrations in beer of 0.2 µg/L or greater. No concentrations of this magnitude were observed in New Zealand beer samples analysed. However, the analysis of composite samples means that occasional high concentrations of OTA in individual beer samples are unlikely to have been detected.

3.2.9 Coffee

Two types of coffee (instant and brewed) were analysed for OTA in the current study. Coffee samples were analysed on an 'as consumed' basis (prepared with boiling water). OTA was not detected in any sample of instant coffee and in one sample (13%) of brewed coffee samples, above the LOD of 0.05 µg/L.

Previous New Zealand studies and the majority of overseas studies have analysed OTA in solid instant or ground coffee or whole coffee beans. Stanton (2000) detected OTA in all of 15 instant coffee samples (0.3-3.5 µg/kg) and in 2 of 6 ground coffee samples (0.94 and 2.7 µg/kg). An unpublished New Zealand study (2007) detected OTA in 7 of 8 ground coffees (0.05-1.48 µg/kg) (D. Saunders, ESR, personal communication).

Two overseas studies were identified in which OTA was determined in coffee prepared ready to drink (Noba *et al.*, 2009; Aoyama *et al.*, 2010). The maximum concentration found in either survey (0.039 µg/L) was less than the LOD of the current study (0.05 µg/L).

3.3 Regulatory Limits for Ochratoxin A

The Joint Australia New Zealand Food Standards Code (the Code) does not include limits for OTA in any food.

In 2003, worldwide regulations for mycotoxins were reviewed (Van Egmond and Jonker, 2004). It should be noted that several countries with separate OTA regulations in 2003 were listed as 'EU candidate' countries. Several of these countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia) have since been admitted to the EU and their mycotoxin regulations will now come under the entry for the EU[3]. Worldwide regulations for ochratoxin A are summarised in Table 6.

Table 6: International regulatory limits for ochratoxin A in cereals, wine, beer and coffee

Food description	Country	Mycotoxin description	Limit (µg/kg)
Coffee and cereals	Cuba	OTA	5
Raw cereal grains (including raw rice and buckwheat) All products derived from cereals (including processed cereal products and cereal grains intended for direct human consumption) Roasted coffee beans and ground roasted coffee, excluding soluble coffee Soluble coffee (instant coffee) Wine (including sparkling wine, excluding liqueur wine and wine with an alcoholic strength of not less than 15% by volume) and fruit wine Aromatised wine, aromatised wine-based drinks and aromatised wine-product cocktails Processed cereal-based foods and baby foods for infants and young children	European Union	OTA	5 3 5 10 2 2 0.5
Coffee (raw and processed)	Greece[1]	OTA	20
Coffee	Indonesia	OTA	Not detectable
Baby food based on cereal without milk Baby instant food (ready to use) Barley, maize Rice, wheat	Iran	OTA	1 1 50 5
Cereals, cereal products and other foods	Israel	OTA	50
Coffee Roasted coffee Beer	Italy[1]	OTA	8 4 0.2
Cereals	Morocco	OTA	30
All foodstuffs	Serbia and Montenegro[2]	OTA	10
Cereals, raw coffee beans Roasted coffee beans	Singapore	OTA	2.5 2.5
Wheat	Sudan	OTA	15
All foodstuffs Processed cereal-based foods and baby foods for infants and young children	Switzerland	OTA	5 0.5
Raw grain Foodstuffs produced from grain	Turkey	OTA	5 3
Rice, barley, beans, coffee, corn	Uruguay	OTA	50

OTA = ochratoxin A

[1] Regulations additional to the harmonised EU regulation

[2] The loose confederation of Serbia and Montenegro effectively came to an end in 2006

[3] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006R1881:20100701:EN:PDF

Where comparison is possible, all OTA concentrations determined in the current study would have been compliant with any of the regulatory limits summarised in Table 6.

4 CONCLUSIONS

OTA was detected in 22 of 208 samples (10.6%) analysed in the current survey. The samples were made up of cereal products (168), wine (16), beer (8) and coffee (16). OTA was most frequently detected in bran flake cereal (4 of 8 samples) and in muesli (3 of 8 samples). These were also the food types containing the highest individual concentrations of OTA (see Appendix 1, Table A1.1). Concentrations of OTA found in New Zealand foods were mostly very low, with only 4 results being above the analytical LOQ. The remaining 18 detected results were at levels between the LOD and LOQ and have been presented in this report as indicative concentrations.

While the Code does not contain regulatory limits for OTA, the concentrations of OTA found in the current study would have been compliant with regulatory limits promulgated in other countries.

Dietary exposure estimates for OTA, considering all potential food sources, would assist in placing the results of the current survey in context with respect to human health risks.

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APPENDIX 1 DETAILS OF SAMPLES ANALYSED IN THE CURRENT SURVEY

Table A1. 1: Ochratoxin A concentrations in New Zealand Total Diet Study (NZTDS) samples of cereal products, wine, beer and coffee

Food Category	Food type	Ochratoxin A (μg/kg or μg/L)[1]							
		First Sampling[2]				Second Sampling[2]			
		1	2	3	4	1	2	3	4
Cereals and Cereal Products	Bread, mixed grain (R)	(0.30)	ND	(0.41)	(0.32)	ND	ND	ND	ND
	Bread, wheatmeal (R)	ND	ND	(0.45)	(0.52)	ND	ND	ND	ND
	Bread, white (R)	ND	ND	(0.55)	(0.40)	ND	ND	ND	ND
	Biscuits, chocolate (N)	ND	ND	ND	ND	ND	ND	ND	ND
	Biscuits, cracker (N)	ND	ND	ND	ND	ND	ND	ND	ND
	Biscuits, sweet plain (N)	(0.42)	ND	ND	(0.20)	ND	ND	ND	ND
	Cornflakes (N)	ND	ND	ND	ND	ND	ND	ND	ND
	Bran flake cereal (N)	(0.20)	ND	(0.30)	1.27	2.99	ND	ND	ND
	Wheat biscuit cereal (R)	ND	ND	ND	ND	ND	ND	ND	ND
	Muesli (N)	ND	ND	1.42	ND	(0.24)	ND	ND	(0.28)
	Oats, rolled (R)	ND	ND	ND	ND	ND	ND	ND	ND
	Cake, plain (R)	ND	ND	ND	ND	ND	ND	ND	ND
	Muffin (R)	ND	ND	ND	ND	ND	(0.33)	ND	ND
	Noodles, instant (N)	ND	ND	ND	ND	0.79	ND	ND	ND
	Pasta, dried (N)	ND	ND	ND	ND	ND	(0.52)	ND	ND
	Rice, white (R)	ND	ND	ND	ND	ND	ND	ND	ND
	Spaghetti in sauce, canned (N)	ND	ND	ND	ND	ND	ND	ND	ND
	Snack bars (N)	ND	ND	ND	ND	(0.21)	ND	ND	(0.30)
	Snacks, flavoured (N)	ND	ND	ND	ND	ND	ND	ND	ND
	Pizza (R)	ND	ND	ND	ND	ND	ND	ND	ND
	Infant weaning food, cereal based (N)	ND	ND	ND	ND	ND	ND	ND	ND
Wine	Wine, still red (N)	ND	ND	ND	ND	ND	ND	ND	ND
	Wine, still white (N)	ND	ND	ND	ND	ND	ND	ND	ND
Beer	Beer (N)	ND	ND	ND	ND	ND	ND	ND	ND
Coffee	Coffee, brewed (R)	ND	ND	ND	(0.09)	ND	ND	ND	ND
	Coffee, instant (N)	ND	ND	ND	ND	ND	ND	ND	ND

[1] Concentration figures in brackets are indicative only and relate to analytical results which lie between the limit of detection and the limit of quantitation of the analytical method.
[2] For nationally distributed foods the sample numbers represent different brands or composites of different brands. For regionally produced foods number represent the sampling location (1 = Auckland, 2 = Napier, 3 = Christchurch, 4 = Dunedin)

R = regional food N = nationally distributed food
ND = Not detected, at a limit of detection of 0.2 μg/kg (solid foods) or 0.05 μg/L (liquid foods)

APPENDIX 2 INTERNATIONAL CONTEXT

Results of some overseas studies of OTA in foods comparable to those analysed in the current study are summarised in Table A2.1. It should be noted that the literature on the prevalence and concentrations of OTA in foods is vast and the material presented in this table should be viewed as representative, rather than exhaustive.

Table A2. 1: Recent overseas studies on the ochratoxin A content of cereals, wine, beer and coffee

Country	Year	Food(s)	Ochratoxin A: Number of samples, positive/total (%)	Ochratoxin A: Range of positive results (µg/kg)	Reference
Cereals					
Belgium	2002-2003	Wheat Conventional Organic	 5/20 (25%) 11/20 (55%)	 0.05-1.1 0.04-0.3	(Pussemier *et al.*, 2006)
Chile	2006	Rice	13/31 (42%)	12.5 (max)	(Vega *et al.*, 2009)
Côte d'Ivoire	2002	Maize Rice	10/10 (100%) 10/10 (100%)	0.14-0.86 0.16-0.91	(Sangare-Tigori *et al.*, 2006)
Croatia	1996-1997	Maize 1996 1997	 10/105 (10%) 36/104 (35%)	 0.4-224 0.3-614	(Jurjevic *et al.*, 1999)
Croatia	2002	Maize	19/49 (39%)	0.9-2.5	(Domijan *et al.*, 2005)
Czech Republic	2006-2008	Bread wheat Feed wheat Feed barley Malting barley	3/12 (25%) 0/10 (0%) 4/7 (57%) 1/3 (33%)	0.3-4.7 0.5-48.6 31.4	(Polisenska *et al.*, 2010)
Denmark	1992-1999	Conventional Wheat Rye Organic Wheat Rye	 188/405 (46%) 257/405 (63%) 8/14 (57%) 4/17 (82%)	 32 (max) 63 (max) 1.6 (max) 45 (max)	(Jørgensen and Jacobsen, 2002)
Ethiopia	1999	Barley Sorghum Teff Wheat	27/103 (26%) 17/78 (22%) 9/33 (27%) 25/107 (23%)	164 (max) 2106 (max) 80 (max) 66 (max)	(Ayalew *et al.*, 2006)
Italy (Puglia)	1999-2000	Durum wheat Maize Barley	6/70 (9%) 19/70 (27%) 8/70 (11%)	1.4 (max) 5.2 (max)	(Palermo *et al.*, 2002)
Japan	2003-2005	Rye	9/10 (90%)	0.3-1.6	(Kumagai *et al.*, 2008)
Jordan	2008-2009	Wheat Barley Rice	5/17 (29%) 1/8 (13%) 1/23 (4%)	2.0-2.6 5.9 2.2	(Salem and Ahmad, 2010)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	**Range of positive results (µg/kg)**	
Morocco	NS	Barley Wheat Maize	11/20 (55%) 8/20 (40%) 8/20 (40%)	0.04-0.8 0.04-1.7 0.05-7.2	(Zinedine *et al.*, 2006)
Morocco	2005	Rice	18/20 (90%)	0.02-32.4	(Zinedine *et al.*, 2007b)
Poland	1997	Conventional Rye Wheat Barley 'Ecological' Rye Wheat Barley	 3/52 (6%) 0/32 (0%) 1/26 (4%) 18/48 (38%) 3/39 (8%) 3/40 (8%)	 0.8-2.5 0.3 0.2-10.0 0.5-1.2 6.7-57	(Czerwiecki *et al.*, 2002a)
Poland	1998	Conventional Rye Wheat Barley 'Ecological' Rye Wheat Barley	 4/37 (11%) 18/37 (49%) 2/36 (6%) 5/46 (11%) 8/34 (24%) 2/17 (12%)	 4.7-8.8 0.6-1024 1.2-9.7 2.0-35.3 0.8-1.6 1.4-35.3	(Czerwiecki *et al.*, 2002b)
Portugal	NS	Rice	6/42 (14%)	0.09-3.5	(Pena *et al.*, 2005)
Spain	NS	Rice and rice products Conventional Organic	 5/64 (8%) 6/20 (30%)	 4.3-27.3 1.0-7.1	(González *et al.*, 2006)
Spain/Portugal	2005	Wheat Maize Oats Barley Rice Rye Spelt Total non-organic cereals Total organic cereals	9/21 (43%) 2/11 (18%) 1/12 (8%) 0/8 (0%) 4/21 (19%) 1/7 (14%) 1/3 (33%) 5/42 (12%) 13/41 (32%)	0.2-8.0 0.8-1.9 2.5 2.1-7.6 27.1 2.2 0.2-0.9 0.3-27.1	(Juan *et al.*, 2008)
Tunisia	2004-2005	Sorghum Wheat and derived products Maize Barley and derived products Rice	9/17 (53%) 31/51 (61%) 4/21 (19%) 13/25 (52%) 4/16 (25%)	2.5-36.4 0.7-24.3 0.9-6.7 0.6-3.4 0.8-2.3	(Ghali *et al.*, 2008)
Tunisia	NS	Wheat Barley Rice Sorghum	42/110 (38%) 41/103 (40%) 27/96 (28%) 43/113 (38%)	11-250 11-940 10-150 8-950	(Zaied *et al.*, 2009)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	Range of positive results (µg/kg)	
Turkey	2002	Barley	26/29 (90%)	0.5-12	(Gumus *et al.*, 2004)
United Kingdom	1993	Wheat at harvest Wheat stored Wheat purchased by millers Barley at harvest Barley stored	0/384 0/25 24/379 (6%) 7/150 (5%) 10/123 (8%)	(LOD = 1) 32 (max) 33 (max) 14 (max)	(MAFF, 1995b)
United Kingdom	1997	Maize, from: France Argentina Other	 11/97 (11%) 1/37 (3%) 2/5 (40%)	 1.4 (max) 0.3 (max) 1.5 (max)	(MAFF, 1999c)
United Kingdom	1997	Barley Oats Rye Wheat	3/37 (8%) 1/18 (6%) 1/22 (5%) 2/76 (3%)	6.4 (max) 5.9 (max) 1.1 (max) 2.4 (max)	(MAFF, 1997)
United Kingdom	1997-1998	Wheat, stored Barley, stored Oats, stored	22/148 (15%) 35/131 (27%) 6/21 (29%)	9.2 (max) 17.8 (max) 2.2 (max)	(MAFF, 1999b)
United Kingdom	2002	Rice and rice products	0/100 (0%)		(Food Standards Agency, 2002b)
United Kingdom	2004	Wheat	34/115 (30%)	0.2-2.5	(Food Standards Agency, 2005b)
Vietnam	NS	Rice	2/25 (8%)	21.3-26.2	(Trung *et al.*, 2001)
Vietnam	NS	Rice	35/100 (35%)	2.8 (max)	(Nguyen *et al.*, 2007)
Cereal products					
Belgium	2002-2003	Wholemeal flour Conventional Organic	 38/40 (95%) 40/40 (100%)	 0.06-1.0 0.14-2.2	(Pussemier *et al.*, 2006)
Canada	1997-1999	Infant cereal foods Oat-based Barley-based Soy-based Rice-based Multi-grain Teething biscuits	 2/6 (33%) 10/47 (21%) 7/22 (32%) 1/8 (13%) 21/72 (29%) 1/5 (20%)	 0.4 (max) 6.9 (max) 0.9 (max) 2.4 (max) 0.9 (max) 0.3 (max)	(Lombaert *et al.*, 2003)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	Range of positive results (µg/kg)	
Canada	1999-2001	Breakfast cereals			(Roscoe *et al.*, 2008)
		Corn-based	6/34 (18%)	0.15 (max)	
		Multi-grain	16/36 (44%)	1.0 (max)	
		Oat-based	17/27 (63%)	1.4 (max)	
		Rice-based	3/29 (10%)	0.22 (max)	
		Wheat-based	11/29 (38%)	0.64 (max)	
		Other	0/1 (0%)		
Canada	2004-2006	Dry pasta			(Ng *et al.*, 2009)
		2004-2005	72/110 (65%)	1.8 (max)	
		2005-2006	24/74 (32%)	1.4 (max)	
		2006-2007	85/90 (94%)	3.3 (max)	
Chile	2006	Wheat flour	21/30 (70%)	2.1 (max)	(Vega *et al.*, 2009)
		Corn starch	12/30 (40%)	1.2 (max)	
Denmark	1993-1999	Conventional			(Jørgensen and Jacobsen, 2002)
		Wheat flour	108/156 (69%)	16 (max)	
		Rye flour	138/165 (84%)	30 (max)	
		Organic			
		Wheat flour	100/120 (83%)	19 (max)	
		Rye flour	140/155 (90%)	68 (max)	
France	NS	Breakfast cereals	31/45 (69%)	0.4-8.8	(Molinié *et al.*, 2005)
Greece	2006-2007	Breakfast cereals			(Villa and Markaki, 2009)
		Conventional	29/47 (62%)	0.02-0.87	
		Organic	4/8 (50%)	0.05-0.19	
Japan	2003-2005	Wheat flour	28/50 (56%)	0.1-0.5	(Kumagai *et al.*, 2008)
		Oatmeal	10/20 (50%)	0.06-0.2	
		Buckwheat flour	8/10 (80%)	0.2-1.8	
Japan	2004-2007	Wheat flour	79/160 (49%)	1.00 (max)	(Aoyama *et al.*, 2010)
		Pasta	56/80 (70%)	1.66 (max)	
		Oatmeal	7/54 (13%)	2.50 (max)	
		Buckwheat flour	15/35 (43%)	2.59 (max)	
		Buckwheat dried noodles	59/107 (55%)	1.48 (max)	
		Polished rice	0/100 (0%)		
		Rice crackers	0/21 (0%)		
		Cornflakes	0/45 (0%)		
Morocco	NS	Breakfast cereals:			(Zinedine *et al.*, 2010)
		Cornflakes	2/20 (10%)	5.1-15.7	
		Muesli	1/10 (10%)	224.6	
		Fruit rings	1/2 (50%)	127.5	
		Other	0/15 (0%)		
Morocco	2006	Bread (wheat)	48/100 (48%)	0.1-149	(Zinedine *et al.*, 2007a)
Portugal	2005	Maize bread	9/15 (60%)	2.65 (max)	(Juan *et al.*, 2007)
Portugal	2007-2008	Bread (various types)	191/274 (70%)	3.8 (max)	(Duarte *et al.*, 2010)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	**Range of positive results (µg/kg)**	
Spain	NS	Breakfast cereal Cereal-based baby foods	19/21 (90%) 14/20 (70%)	0.98 (max) 0.74 (max)	(Araguás *et al.*, 2005)
Spain	NS	Bread	2/20 (10%)	1.8-2.6	(González-Osnaya *et al.*, 2006)
Spain	NS	Bread Conventional Organic	 15/74 (20%) 6/26 (23%)	 0.04-19.6 0.03-0.8	(González-Osnaya *et al.*, 2007)
Spain	NS	Breakfast cereals Corn Wheat Wheat and rice	 1/21 (5%) 9/14 (64%) 7/8 (88%)	 0.1 1.1 (max) 0.2 (max)	(Ibáñez-Vea *et al.*, 2011)
Turkey	2002-2003	Wheat flour Other cereal-based flours and starches	12/12 (100%) 8/9 (89%)	0.4-2.2 0.3-4.1	(Baydar *et al.*, 2005)
Turkey	2007	Breakfast cereals Cereal-based infant foods	9/24 (38%) 4/24 (17%)	0.2-1.8 0.1-0.4	(Kabak, 2009)
United Kingdom	2005	Maize/corn products	6/292 (2%)	0.2-1.7	(Food Standards Agency, 2005a)
Wine					
Argentina	2008	Red wine	4/47 (8.5%)	0.02-4.8	(Ponsone *et al.*, 2010)
Argentina	NS	Red wine White wine	2/7 (29%) 0/5 (0%)	0.03-0.04	(Rosa *et al.*, 2004)
Australia	NS	White wine Red wine	41/257 (16%) 49/354 (14%)	0.5 (max) 0.6 (max)	(Hocking *et al.*, 2003)
Brazil	NS	Red wine White wine Rosé wine	3/10 (30%) 2/10 (20%) 1/5 (20%)	0.03-0.04 0.03 0.04	(Rosa *et al.*, 2004)
Chile	NS	Red wine	2/5 (40%)	0.03-0.07	(Rosa *et al.*, 2004)
China	2008-09	Red wine White wine	18/63 (29%) 4/42 (10%)	0.02-1.2 0.09-0.5	(Wu *et al.*, 2011)
Croatia	2007	Red wine	8/10 (80%)	0.005-0.021	(Flajs *et al.*, 2009)
Greece	1995-99	Red wine, dry White wine, dry Rosé wine, dry Dessert wine Retsina	71/104 (68%) 63/118 (53%) 13/20 (65%) 15/18 (83%) 6/8 (75%)	2.7 (max) 1.7 (max) 1.2 (max) 2.8 (max) 1.8 (max)	(Stefanaki *et al.*, 2003)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	Range of positive results (µg/kg)	
Greece	1999-2006	Red wine, dry White wine, dry Rosé wine, dry Red dessert wine White dessert wine	45/64 (70%) 31/49 (63%) 6/10 (60%) 13/14 (93%) 9/13 (69%)	1.3 (max) 0.5 (max) 0.4 (max) 2.0 (max) 1.2 (max)	(Labrinea *et al.*, 2011)
Italy	2000-2007	White wine Red wine	125/204 (61%) 695/1002 (69%)	1.4 (max) 2.6 (max)	(Spadaro *et al.*, 2010)
Japan	2004-2005	Wine	8/10 (80%)	0.02-0.72	(Kumagai *et al.*, 2008)
Morocco	NS	Wine	30/30 (100%)	0.03-3.2	(Zinedine and Mañes, 2009)
Poland	NS	Red wine (imported)	49/53 (92%)	0.002-6.7	(Czerwiecki *et al.*, 2005)
Portugal	NS	Red wine White wine	9/35 (26%) 3/25 (12%)	1.2 (max) 2.4 (max)	(Pena *et al.*, 2010)
Spain	1997-1998	Wine 1997 1998	 17/20 (85%) 3/20 (15%)	 0.06-0.32 0.07-0.19	(López de Cerain *et al.*, 2002)
Spain	2003	'Special' wines	32/40 (80%)	0.04-0.53	(Murillo-Arbizu *et al.*, 2010)
Spain	2003	Wine	45/119 (38%)	0.06-0.76	(Blesa *et al.*, 2004)
Spain	2006-07	Red wine	20/20 (100%)	0.0005-0.04	(Remiro *et al.*, 2010)
Spain	1995-2008	Rioja Alavesa wine: Joven Crianza Reserva Gran Reserva White Rosé	 17/32 (53%) 26/41 (63%) 10/8 (56%) 1/3 (33%) 2/3 (67%) 1/3 (33%)	 0.007-0.18 0.004-0.17 0.004-0.06 0.05 0.01-0.02 0.007	(Quintela *et al.*, 2011)
Spain	NS	Wine	1/9 (11%)	1.1	(Romero-González *et al.*, 2010)
United Kingdom	1997	Red wine White wine	4/10 (40%) 0/10 (0%)	1.1 (max)	(MAFF, 1997)
United Kingdom	1999	Red wine	28/50 (56%)	0.01-0.8	(MAFF, 1999a)
Beer					
Belgium	NS	Beer Domestic Imported	 60/62 (97%) 20/20 (100%)	 0.01-0.19 0.01-0.09	(Tangni *et al.*, 2002)
Belgium	2003-2004	Beer Conventional Organic	 31/40 (78%) 40/40 (100%)	 0.02-0.20 0.02-1.13	(Anselme *et al.*, 2006)
Brazil	2003-2004	Beer	5/123 (4%)	1.0-18.0	(Kawashima *et al.*, 2007)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	Range of positive results (µg/kg)	
Canada	NS	Beer, domestic and imported	26/41 (63%)	0.015-0.17	(Scott and Kanhere, 1995)
China	2008-2009	Beer	0/20 (0%)		(Wu *et al.*, 2011)
Czech Republic	2008-2009	Pale beer Dark beer Special beer Non-alcoholic beer	30/72 (42%) 8/18 (44%) 4/0 (40%) 5/15 (33%)	0.001-0.24 0.002-0.05 0.002-0.05 0.001-0.05	(Beláková *et al.*, 2011)
Denmark	1995	Beer	21/21 (100%)	0.16 (max)	(Jørgensen, 1998)
Europe	2010-11	Beer	72/106 (68%)	0.19 (max)	(Bertuzzi *et al.*, 2011)
Italy	NS	Beer, domestic and imported	30/61 (49%)	0.01-0.14	(Visconti *et al.*, 2000)
Japan	1998	Beer Domestic Imported	 21/22 (96%) 86/94 (92%)	 0.002-0.045 0.001-0.066	(Nakajima *et al.*, 1999)
Japan	2004-2005	Beer	4/20 (70%)	0.01-0.05	(Kumagai *et al.*, 2008)
Morocco	NS	Beer	0/5 (0%)		(Zinedine and Mañes, 2009)
Spain	NS	Beer	24/31 (77%)	0.21 (max)	(Araguás *et al.*, 2005)
Spain	NS	Beer, domestic and imported	73/88 (83%)	0.01-0.20	(Medina *et al.*, 2005)
Spain	NS	Beer, domestic and imported	69/69 (100%)	0.008-0.50	(Medina *et al.*, 2006)
Spain	NS	Beer	0/8 (0%)		(Romero-González *et al.*, 2010)
Turkey	NS	Beer, domestic and imported	42/150 (28%)	0.1-8.1	(Gumus *et al.*, 2004)
Turkey	2007	Beer	5/35 (14%)	0.012-0.05	(Kabak, 2009)
United Kingdom	1997	Beer	0/20 (0%)		(MAFF, 1997)
Various (review of other studies)	NS	Beer	852/1346 (63%)	0.001-2.3	(Kabak, 2009)
Coffee					
Brazil	2004	Instant coffee	81/82 (99%)	0.17-6.3	(De Almeida *et al.*, 2007)
Denmark	1995	Roasted coffee (beans)	11/11 (100%)	3.2 (max)	(Jørgensen, 1998)
France	NS	Ground roast coffee	29/30 (97%)	Tr-15.1	(Tozlovanu and Pfohl-Leszkowicz, 2010)
Japan	2004-2005	Roast coffee	3/9 (33%)	0.11-0.33	(Kumagai *et al.*, 2008)

Country	Year	Food(s)	Ochratoxin A		Reference
			Number of samples, positive/total (%)	Range of positive results (µg/kg)	
Japan	NS	Coffee, ready-to-drink	30/30 (100%)	0.002-0.037	(Noba *et al.*, 2009)
Jordan	2008-2009	Green coffee	7/11 (63%)	2.2-6.6	(Salem and Ahmad, 2010)
Spain	2008	Ground roast coffee			(Coronel *et al.*, 2011)
		Brand samples	43/45 (96%)	1.3-5.2	
		Composites	35/72 (49%)	1.2-4.2	
United Kingdom	1995	Retail coffee			(MAFF, 1995a)
		Soluble	64/80 (80%)	0.1-8.0	
		Roast/ground	17/20 (85%)	0.2-2.1	
United Kingdom	1996	Green coffee beans	110/291 (38%)	27.3 (max)	(MAFF, 1996)

max = maximum reported concentration
NS = not stated
LOD = limit of detection