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FW08027 Aflatoxins in Maize Products

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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

FW08027 Aflatoxins in Maize Products

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

<u>Aflatoxins in Maize Products 2008</u>

New Zealand dietary occurrence data for Aflatoxins (AF) was identified as the highest priority in the 2006 risk profile and thus it was the first mycotoxin to be surveyed.

The report details the sampling protocol and analytical mythology for the survey of 70 maize containing foods. The detail on the analytical methodology gives confidence that the results are accurate to actual occurrence.

Only four samples had detectable levels of AF and these results were very low. One of the samples also contained peanuts which may have been the source of the AF levels. The results are consistent to previous New Zealand surveys and values reported from overseas.

MYCOTOXIN SURVEILLANCE PROGRAMME 2007-08
AFLATOXINS IN MAIZE PRODUCTS

Prepared as part of a New Zealand Food Safety Authority
contract for scientific services

by

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April 2008

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Client Report
FW08027

MYCOTOXIN SURVEILLANCE PROGRAMME 2007-08
AFLATOXINS IN MAIZE PRODUCTS

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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. During 2007-2008, the MSP began analysis of the presence of aflatoxins in foods other than those currently covered by import Standard Management Rules (SMRs), peanuts and pistachio nuts. The foods initially targeted were those containing maize.

Very low concentrations of aflatoxins were detected in four of 70 maize containing foods analysed in the current survey. In one case, the presence of aflatoxins was probably due to the presence of peanut in the same food.

The concentrations of aflatoxin detected (0.2-1.1 μg/kg of total aflatoxin) are consistent with overseas studies of the aflatoxin content of manufactured maize products.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) have reviewed information on aflatoxins and concluded that "aflatoxins should be treated as carcinogenic food contaminants, the intake of which should be reduced to levels as low as reasonably achievable" (JECFA, 1998). However, JECFA also concluded that the maximum reduction in cancer risk would be achieved by removing heavily contaminated material from the food supply. The very low level of contamination in samples analysed in the current survey are unlikely to contribute significantly to cancer risk for New Zealanders.

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 New Zealand Food Safety Authority (NZFSA), 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.

During 2007-2008, the MSP began analysis of the presence of aflatoxins in foods other than those currently covered by import Standard Management Rules (SMRs), peanuts and pistachio nuts. The foods initially targeted were those containing maize.

1.1 Hazard Identification

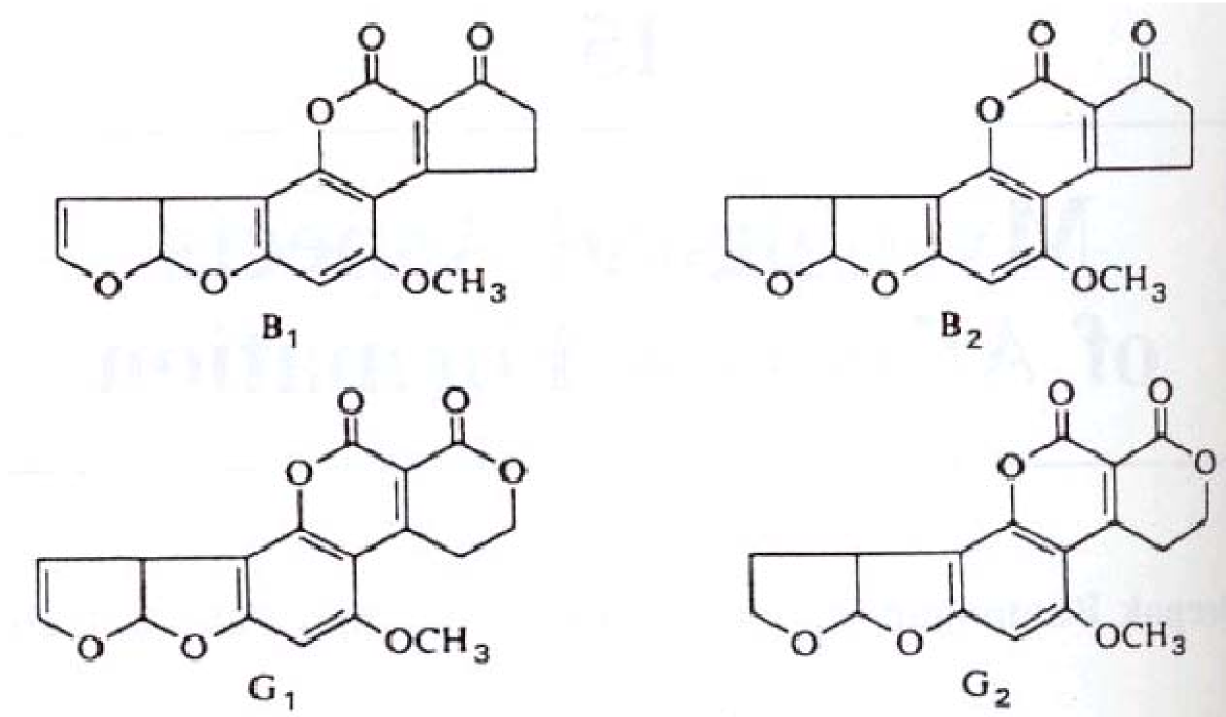
Aflatoxins are secondary metabolites produced by three species of *Aspergillus* mould: *A. flavus, A.. parasiticus* and *A. nomius* (JECFA, 1998). *A. flavus* occurs in all tropical and subtropical regions and is particularly associated with peanuts and other nuts, maize and other oilseeds. *A. parasiticus* is less widely distributed and is usually only associated with peanuts (Pitt and Tomaska, 2001). *A. nomius* is closely related to *A. flavus*, but little information is available on its host range (Kurtzman *et al.*, 1987).

1.1.1 Structure and nomenclature

While the aflatoxins comprise a group of about 20 related compounds, the four major naturally-occurring compounds are aflatoxins B_1, B_2, G_1 and G_2. The ‘B’ and ‘G’ refer to the blue and green fluorescent colours produced by these compounds under UV light, while the subscripts ‘1’ and ‘2’ refer to major and minor components respectively (Pitt and Tomaska, 2001). The ‘2’ compounds are dihydro derivatives of the major (‘1’) metabolites. Chemical structures are shown in Figure 2. Aflatoxins M_1 and M_2 are hydroxylated metabolites of the respective ‘B’ aflatoxins produced when ruminant animals consume aflatoxin-contaminated feed. The ‘M’ aflatoxins may be excreted in milk (Pitt and Tomaska, 2001). Aflatoxins are fat soluble (lipophilic).

Reference to ‘aflatoxins’ or ‘total aflatoxins’ can be taken to refer to the sum of B and G aflatoxins.

Figure 1: Structure of aflatoxins



Reproduced from Eaton and Groopman (Eaton and Groopman, 1994)

1.1.2 Occurrence

A. flavus produces only 'B' aflatoxins (AFB_1 and AFB_2), with only about 40% of isolates producing toxins. *A. parasiticus* produces both 'B' (AFB_1 and AFB_2) and 'G' (AFG_1 and AFG_2) aflatoxins, with virtually all isolates producing toxins (Klich and Pitt, 1988). The situation for *A. nomius* appears to be similar to that for *A. parasiticus.*

Aflatoxin B_1 is the most commonly occurring aflatoxin in foods and is also the compound which has been most thoroughly studied in toxicological studies.

A. flavus occurs widely in the environment, but *A. parasiticus* is considerably less common. However, some regional specificities exist and *A. parasiticus* is commonly isolated from peanuts in the United States, South Africa and Australia.

Fungal infection and consequent aflatoxin contamination can occur in field crops prior to harvest or during post-harvest storage if the moisture content of the crop exceeds critical values for fungal growth (JECFA, 1998). Fungal growth and subsequent toxin production are favoured by factors which place the host plant under stress such as high temperature, drought, and high insect activity.

Aflatoxin contamination is most commonly associated with peanuts and peanut products, dried fruit, tree nuts, spices, figs, crude vegetable oils, cocoa beans, maize, rice, cottonseed and copra (JECFA, 1998). Consumption of aflatoxin-contaminated feed by animals can lead to occurrence of aflatoxins (mainly the hydroxylated metabolite AFM_1) in meat, eggs and milk.

Most of these crops are not grown in New Zealand. Surveillance of fungal infections of New Zealand grown grain found no *Aspergillus* species (Sayer and Lauren, 1991). This is consistent with expert opinion, that aflatoxigenic species of *Aspergillus* are unlikely to occur in New Zealand (Pitt JI, Mycologist, Food Science Australia, personal communication; 1999).

2 MATERIALS AND METHODS

2.1 Foods Sampled

In a survey carried out during 2000, three categories of maize-based foods were recognised (Stanton, 2000): Maize snacks, maize products (canned sweet corn, maize flour) and breakfast cereals.

In a survey of *Fusarium* toxins in maize-based foods in New Zealand, products were classified into eight categories (Lauren and Veitch, 1996):

- Breakfast cereals;
- Extruded snack foods;
- Maize meal products;
- Breads;
- Masa flour products (corn chips, taco shells);
- Snack bars;
- Maize oil; and
- Miscellaneous products (corn syrup, brewing sugar)

The categorisation of Lauren and Veitch was used as a starting point for the current project. No references were found to the detection of aflatoxins in maize oil, corn syrup or brewing sugar and was agreed that these products be excluded from the current project.

Toasting, wet milling, extrusion and nixtamalisation (the process used to make taco shells and corn chips) are all reported to reduce aflatoxin levels from those in the raw maize (see Cressey and Thomson, 2006 for a review of these processing factors). This suggests that aflatoxins are most likely to be detected in minimally processed maize. This is in line with exploratory work carried out for the NZFSA in 2005, where aflatoxins were detected in imported polenta (maize meal).

It was agreed that the sampling for the current project would target:

- Maize meal products, including maize pastas 15
- Snack bars 15
- Breakfast cereals 15
- Breads 10
- Extruded snack foods 10
- Masa products 5

Changes in product markets since the survey of Lauren and Veitch (1996) meant that some of these target numbers were not achievable. Final categories and samples numbers were:

- Maize meal products, including maize pastas 15
- Snack bars 11
- Breakfast cereals 16
- Baked cereal products (breads, biscuits, cracker) 13
- Extruded snack foods 9
- Masa products 5
- Other (popcorn) 1

Details of samples included in the survey are included in Appendix 1.

2.2 Sampling Plan – Sampling Protocols

The UK Food Standard Agency recently updated their advice on the sampling of foodstuffs for mycotoxin analyses (Food Standards Agency, 2007). For sampling of retail packets of cereals or cereal products it is recommended that sufficient retail units are purchased to obtain an aggregate sample weight of 1 kg, with all units coming from the same batch. This protocol has been employed in the UK for surveys of mycotoxins in retail products (see http://www.food.gov.uk/multimedia/pdfs/nuts_q_a.pdf for a Q&A, including a discussion of this issue. This protocol was used for a very similar survey of mycotoxins in retail maize-based products carried out for the FSA in 2005 (Food Standards Agency, 2005).

EC Directive 98/53 specifies sampling rates for sampling of bulk shipments for analysis for aflatoxins (http://www.safefoodnet.net/attachments/Dir1998_53.pdf). For cereals, the Directive specifies 100 subsamples making up a total weight of 30 kg for lots of greater than 50 tonnes and 10-100 subsamples making up a total weight of 1-10 kg for lots of less than 50 tonnes. The Directive states that sampling of retail products should conform as closely to this protocol as possible or "Where this is not possible, other effective sampling procedures at retail stage can be used provided that they ensure sufficient representativeness for the sampled lot."

A report of the European Commission Working Group on Agricultural Contaminants on Sampling and Analysis of Aflatoxins and Ochratoxins further discussed the issue of sampling retail packaged products, but did not further elaborate strategies for sampling at the retail levels (http://archive.food.gov.uk/pdf_files/ecreport.pdf).

For the current survey it was agreed that analytical samples be made up by blending individual purchase units to a combined weight of approximately one kilogram, with all samples coming from a single batch.

2.3 Aflatoxin Analytical Methodology

Samples were extracted with methanol-water (60:40), filtered and cleaned up using Aflatest immunoaffinity columns (Vicam, Watertown, USA) according to the method of Karaca and Nas (Karaca and Nas, 2006). Aflatoxins were eluted from the immunoaffinity column with acetonitrile.

Aflatoxin analyses were based on the method of Takahashi (Takahashi, 1977). Extracts were prepared for HPLC by removing acetonitrile under reduced pressure, then adding 100 µl of trifluoroacetic acid and dissolving in 900 µl of water-acetonitrile (9:1).

Aflatoxins (20 µl) were separated by HPLC on a C-18 reversed-phase column with acetonitrile-water (20:80) as the mobile phase at a flow rate of 1.5 ml/minute. Fluorescence detection was carried out with an excitation wavelength of 360 nm and an emission wavelength of 470 nm.

The method allows quantitation of the four principle aflatoxins (B_1, B_2, G_1 and G_2) with a limit of detection of 0.1 µg/kg per aflatoxin.

2.3.1 Analytical quality control

A maize quality control material (FAPAS – Food Analysis Performance Assessment Scheme, operated by Central Science Laboratory, Sand Hutton, York, United Kingdom) was analysed in duplicate. Results of the analyses are shown in Table 1.

Table 1: Analysis of maize quality control material

Aflatoxin	Assigned value (µg/kg)	Satisfactory range (µg/kg)	ESR analytical results (µg/kg)
B1	4.66	2.61-6.71	3.22, 3.39
B2	1.46	0.82-2.11	1.34, 1.35
G1	2.13	1.19-3.06	1.65, 1.70
G2	0.43	0.24-0.62	0.38, 0.36
Total	8.68	5.04-12.96	6.59, 6.79

A mixed aflatoxin standard was made up in a blank food matrix (peanut) at 0.5 µg/kg per aflatoxin and analysed in duplicate with each analytical batch. Mean and standard deviation for the recovery of each aflatoxin (n = 19) were:

- Aflatoxin B_1 mean = 93% standard deviation = 17%
- Aflatoxin B_2 mean = 83% standard deviation = 12%
- Aflatoxin G_1 mean = 59% standard deviation = 18%
- Aflatoxin G_2 mean = 63% standard deviation = 20%

While recoveries of G aflatoxins are less than ideal they are similar to other published recoveries for these compounds (Leblanc *et al.*, 2005). It should also be noted that the B aflatoxins are always the predominant compounds detected in foods.

3 RESULTS AND DISCUSSION

Results for the 70 maize-containing foods analysed in the current study are summarised in Table 2.

Table 2: Aflatoxin content of maize-containing foods available on the New Zealand market

Food type	Number of samples	Number positive for aflatoxins (%)	Total aflatoxins in positive samples (µg/kg)	Aflatoxins detected
Maize meal products	15	0		
Snack bars	11	1	0.2	B1
Breakfast cereals	16	2	0.2, 1.1	B1, B2, G1
Baked cereal products	13	1	0.7	B1, B2
Extruded snack foods	9	0		
Masa products	5	0		
Other	1	0		

While aflatoxins were detected in four samples (5.7%), in all cases the concentrations of aflatoxin detected were very low. An earlier New Zealand study analysed approximately 40 maize-containing foods, as part of a wider survey, but did not detect aflatoxins in any samples at a limit of detection of 1 µg total aflatoxin/kg (Stanton, 2000). The current survey was able to achieve a ten-fold lower limit of detection.

The baked cereal product containing 0.7 µg/kg of total aflatoxin included peanut as an ingredient, as well as maize. It is not possible to determine whether aflatoxins were present in this food due to the presence of maize or the presence of peanut.

3.1 International Context

While many studies have been carried out to examine the aflatoxin content of maize, relatively few have examined the aflatoxin content of processed maize products. Results of some overseas studies are summarised in Table 3.

Table 3: Overseas studies on the aflatoxin content of processed maize products

Country	Year	Food(s)	Number of samples (positive/total)	Range of positive results (µg/kg)	Reference
Argentina	1997	Corn meal (polenta) Corn flakes	0/21 (LOD = 2) 0/17 (LOD = 2)		(Solovey *et al.*, 1999)
Indonesia	2001-2002	Maize-based products	2/11 (18%)	5.8-12.4 Total	(Razzazi-Fazeli *et al.*, 2004)

Country	Year	Food(s)	Number of samples (positive/total)	Range of positive results (µg/kg)	Reference
Japan (Osaka)	1988-1992	Corn products	0/5 (LOD = 0.1)		(Taguchi *et al.*, 1995)
Korea	1998-1999	Corn foods (corn meal, corn flour, roasted corn, corn snack)	4/47 (8%)	14-25 AFB1	(Park *et al.*, 2002)
Korea	2004-2005	Corn flake	0/92 (LOD = 0.05)		(Ok *et al.*, 2007)
Sweden	1996-1998	Buckwheat and maize products	16/66 (24%)	0.01-0.7 Total	(Thuvander *et al.*, 2001)
UK	2003	Maize-based retail foods (sweetcorn, corn on the cob, baby food, corn oil, cornflour, polenta, maize meal, maize pasta, maize-based snacks, tortillas)	1/292 (0.3%)	0.38 Total	(Food Standards Agency, 2005)
USA	1986	Manufactured corn-based products	0/23		(Wood, 1989)

AFB1 = Aflatoxin B_1 Total = total aflatoxins ($B_1 + B_2 + G_1 + G_2$)

Surveys of raw maize have shown prevalence of aflatoxin contamination as high as 100% in some countries (Cressey, 2003). However, the results of the current survey and other studies summarised in Table 3 suggest that processing of maize to produce manufactured foods was a significant impact on the aflatoxin content. Common processes for maize, such as wet or dry milling, extrusion and nixtamalisation have all been shown to decrease the aflatoxin concentration in maize (see Cressey, 2003 for a summary).

3.2 Regulatory Limits for Aflatoxins

The Joint Australia New Zealand Food Standards Code does not include any limits for aflatoxins in maize or maize products.

In 2003, worldwide regulation for mycotoxins were reviewed (Van Egmond and Jonker, 2003). The EU had limits for aflatoxin B_1 in cereals and processed products thereof of 2 µg/kg and a limit of 4 µg/kg for total aflatoxins. USA had a limit of 20 µg/kg of total aflatoxins in all foods. Overall, regulatory limits that could be applied to maize products ranged from 0 to 35 µg/kg for total aflatoxins, with a median of 10 µg/kg.

The results from the current survey would be compliant with most international mycotoxin regulations.

4 CONCLUSIONS

Very low concentrations of aflatoxins were detected in four of 70 maize containing foods analysed in the current survey. In one case, the presence of aflatoxins was probably due to the presence of peanut in the same food.

The concentrations of aflatoxin detected (0.2-1.1 µg/kg of total aflatoxin) are consistent with overseas studies of the aflatoxin content of manufactured maize products.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) have reviewed information on aflatoxins and concluded that "aflatoxins should be treated as carcinogenic food contaminants, the intake of which should be reduced to levels as low as reasonably achievable" (JECFA, 1998). However, in considering aflatoxin exposure from maize and peanuts, JECFA also concluded that the maximum reduction in cancer risk would be achieved by removing heavily contaminated material from the food supply. JECFA further concluded that for populations with a low prevalence of hepatitis B and a low mean dietary exposure to aflatoxins there was unlikely to be detectable differences in population risk for standards defining maximum limits for aflatoxins in foods of 20 or 10 µg/kg. The very low level of contamination in samples analysed in the current survey are unlikely to contribute significantly to cancer risk for New Zealanders.

A resent JECFA assessment of aflatoxins in tree nuts and dried figs reached similar conclusions, stating that "for tree nuts other than pistachios, the presence of an ML (maximum limit) has no effect on AFL (aflatoxin) dietary exposure. Moreover, the Committee concluded that enforcing an ML of 15, 10, 8, or 4 µg/kg, would have little further impact on the overall dietary exposure to AFT (*sic*) in all five of the highest exposed population groups compared to setting an ML of 20 µg/kg" (JECFA, 2007).

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APPENDIX 1 DETAILS OF SAMPLES ANALYSED IN THE CURRENT SURVEY

Category	Name	Manufacturer	Maize Ingredients (as stated on ingredient label)	Aflatoxin Concentration (µg/kg)			
				B1	B2	G1	G2
Baked Cereal Products	Peanut Crunch Cookies	Naturally Good	Maize Flour	0.5	0.2	ND	ND
Baked Cereal Products	Choc Chip Cookies	Waimari French Bakery	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Afghan Biscuits	Waimari French Bakery	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Cassava Bread	Breadman	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Multigrain Corn Thins	Real Foods	Maize	ND	ND	ND	ND
Baked Cereal Products	Rice & Cracked Pepper Crispi Bread	Orgran	Maize	ND	ND	ND	ND
Baked Cereal Products	Original Brown Rice (Bread)	Venerdi	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Crunchy Corn Crackers 250g	Breadman	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Gluten Free Corn & Seed Bread	Purebread	Maize starch, Corn Meal (polenta)	ND	ND	ND	ND
Baked Cereal Products	Six Seeds	Venerdi	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Original Brown Rice (Bread)	Venerdi	Maize Flour	ND	ND	ND	ND
Baked Cereal Products	Easy Bake Bread Mix	Orgran	Maize starch, dextrose from maize	ND	ND	ND	ND
Baked Cereal Products	Buckwheat	Bread Man	Maize Flour, Maizemeal	ND	ND	ND	ND
Breakfast Cereals	Instant 3 in 1 cereal	Gold kili	Maize	0.9	0.1	0.1	ND
Breakfast Cereals	Power Tri-Grain Cereal	Sunreal	Maize Flour	ND	ND	ND	ND
Breakfast Cereals	Cornflakes	Kelloggs	Corn (Maize)	0.2	ND	ND	ND
Breakfast Cereals	Cheerios	Nestle	Whole grain corn	ND	ND	ND	ND
Breakfast Cereals	Sunrise, Blueberry	Tasti	Cornflakes	ND	ND	ND	ND
Breakfast Cereals	Corn Flakes with Psyllium	Freedom Foods	Corn, Maltodextrin (corn)	ND	ND	ND	ND
Breakfast Cereals	Rice Flakes with Psyllium	Freedom Foods	Maize Flour	ND	ND	ND	ND
Breakfast Cereals	Fruit and Fibre	WeightWatchers	Cornflakes	ND	ND	ND	ND
Breakfast Cereals	Crunchy Grain	Home Brand	Maize Flour	ND	ND	ND	ND
Breakfast Cereals	Outward Bound	Hubbards	Corn Flour	ND	ND	ND	ND
Breakfast Cereals	Corn Flakes (Organic)	Nature's Path	Corn meal	ND	ND	ND	ND

Category	Name	Manufacturer	Maize Ingredients (as stated on ingredient label)	Aflatoxin Concentration (µg/kg)			
				B1	B2	G1	G2
Breakfast Cereals	SimpleTropical Light Cereal	Healtheries	Cornflakes	ND	ND	ND	ND
Breakfast Cereals	Rice Puffs	Freedom Foods	Maize Flour	ND	ND	ND	ND
Breakfast Cereals	Ultra-Rice	Freedom Foods	Maize Flour	ND	ND	ND	ND
Breakfast Cereals	Crispix honey	Kelloggs	Corn (cornflour)	ND	ND	ND	ND
Breakfast Cereals	Instant Black Rice Cereal	Super	Maize	ND	ND	ND	ND
Extruded Snack Foods	Rashuns	Bluebird	Corn	ND	ND	ND	ND
Extruded Snack Foods	Twisties	Bluebird	Corn	ND	ND	ND	ND
Extruded Snack Foods	Cruncheese	Eta	Corn	ND	ND	ND	ND
Extruded Snack Foods	Cheese Twists	Signature Range	Corn, Hydrolysed Maize protein	ND	ND	ND	ND
Extruded Snack Foods	Pringles original	Pringles	Corn flour	ND	ND	ND	ND
Extruded Snack Foods	Cheesels	Bluebird	Corn	ND	ND	ND	ND
Extruded Snack Foods	Biguns	Bluebird	Corn	ND	ND	ND	ND
Extruded Snack Foods	Grain Waves	Bluebird	Corn	ND	ND	ND	ND
Extruded Snack Foods	Burger rings	Bluebird	Corn	ND	ND	ND	ND
Maize Meal Products	Organic Polenta, Yellow Maize Meal	Kaiora Organic	Maize	ND	ND	ND	ND
Maize Meal Products	Instant Polenta	Molino Bordignon	Cornmeal	ND	ND	ND	ND
Maize Meal Products	Fine Ground Cornmeal	Healtheries	Fine Cornmeal	ND	ND	ND	ND
Maize Meal Products	Simple Rigatoni	Healtheries	Maize Starch, Maize Flour	ND	ND	ND	ND
Maize Meal Products	Pancake Shake Buttermilk	Basco	Maize Starch, Maize Flour	ND	ND	ND	ND
Maize Meal Products	Lasagne	Orgran	Maize Meal	ND	ND	ND	ND
Maize Meal Products	Chocolate Cake mix-Gluten Free	Orgran	Maize starch, Maize flour	ND	ND	ND	ND
Maize Meal Products	Chocolate Cake mix-Gluten Free Foods	Basco	Maize flour, Glucose syrup,solids (from Maize), Maize starch	ND	ND	ND	ND
Maize Meal Products	Pizza & Pastry multimix Gluten Free	Orgran	Maize starch, Maize flour	ND	ND	ND	ND
Maize Meal Products	Rice & Corn Spaghetti Noodles	Organ	Maize Meal	ND	ND	ND	ND
Maize Meal Products	Corn & Vegetable Pasta	Organ	Maize Meal	ND	ND	ND	ND

Category	Name	Manufacturer	Maize Ingredients (as stated on ingredient label)	Aflatoxin Concentration (µg/kg)			
				B1	B2	G1	G2
Maize Meal Products	Gluten Free Penne	San Remo	Maize Starch	ND	ND	ND	ND
Maize Meal Products	Tomato & Basil Macaroni	Casalare	Maize Flour	ND	ND	ND	ND
Maize Meal Products	Polenta	SunValley	De-germed Whole Corn Ground	ND	ND	ND	ND
Maize Meal Products	Simple Spaghetti	Healtheries	Maize Starch, Maize Flour	ND	ND	ND	ND
Masa Products	Sancho Corn Chips, Nacho Cheese	Eta	Corn	ND	ND	ND	ND
Masa Products	Corn Chips, Cheese	Mexicano	Corn	ND	ND	ND	ND
Masa Products	Sancho Corn Chips, Cheesy Cheese	Eta	Corn	ND	ND	ND	ND
Masa Products	Party Corn Chips, Cheese	Bluebird	Corn	ND	ND	ND	ND
Masa Products	Corn Tapas, Poppy Seed & Cheddar	Eta	Corn	ND	ND	ND	ND
Other	Popcorn	POP'N'GOOD	Aired popped popcorn, Hydrolysed plant protein (Soy, Maize)	ND	ND	ND	ND
Snack Bars	XanaBar, Hazlenut, Chocolate and Caramel	Tasti	Cornflakes	ND	ND	ND	ND
Snack Bars	Nutri-Grain Bar	Kelloggs	Maize Flour	ND	ND	ND	ND
Snack Bars	Nice & Natural Delectables Apple & Cinnamon Bar	Nice & Natural	Cornflakes	0.2	ND	ND	ND
Snack Bars	Muesli Breakfast Bar	Freedom Foods	Corn Starch	ND	ND	ND	ND
Snack Bars	Orgran Blueberry Bar	Orgran	Milled corn	ND	ND	ND	ND
Snack Bars	Muesli Breakfast Bar	Freedom Foods	Maltodextrin (Corn), Corn Starch	ND	ND	ND	ND
Snack Bars	XanaBar, Hazlenut, extremely cashew	Tasti	Cornflakes	ND	ND	ND	ND
Snack Bars	Nutri-Grain Bar	Kelloggs	Maize Flour	ND	ND	ND	ND
Snack Bars	Muesli Bars Yoghurt & Apricot	Pam's	Cornflakes	ND	ND	ND	ND
Snack Bars	Nice & Natural Delectables Orange & Cranberry Bar	Nice & Natural	Cornflakes	ND	ND	ND	ND
Snack Bars	Real Fruit Bars apricot	Flemings	Maize maltodextrin	ND	ND	ND	ND

ND = Not detected, at a limit of detection of 0.1 µg/kg