

National Chemical Contaminants Programme

Dairy products and raw milk

Dioxin, dioxin-like PCB, and indicator PCB results (2014/15, 2015/16, 2016/17 and 2017/18)

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Requests for further copies should be directed to:

Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
WELLINGTON 6140

Email: brand@mpi.govt.nz
Telephone: 0800 00 83 33
Facsimile: 04-894 0300

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1 Summary

This National Chemical Contaminants Programme (NCCP) report provides results of testing for dioxins, dioxin-like polychlorinated biphenyls (dioxin-like PCBs) and some non-dioxin like polychlorinated biphenyls (indicator PCBs) in a range of dairy products and milk, sampled over the 2014/15, 2015/16, 2016/17 and 2017/18 dairy seasons.

Dioxins and PCBs are unintended, or undesired, by-products of chemical processes in the chlorine-based chemical industry and any combustion process involving chlorine or organic carbon under specific circumstances. These substances are referred to as environmental contaminants and can enter foodstuffs through air, soil or sediments.

New Zealand is geographically isolated and not heavily industrialised, so the risk of dioxins or PCBs entering the milk supply is very low. This has been confirmed in historic surveys. Nonetheless, surveys of dairy products and milk for dioxins and PCBs are periodically undertaken to confirm the suitability of manufacturing practices and environments and to support the NCCP monitoring of raw milk used for the manufacture of dairy products.

The NCCP monitoring programmes combine to provide a high level of confidence in the safety and suitability of New Zealand dairy products. The levels detected do not exceed the most appropriate science-based overseas standards for the sum of dioxins and PCBs. This means that the risk of dioxins or PCBs entering the milk supply is very low and that, in this regard, the dairy products manufactured are safe and suitable for their intended purpose.

2 What we tested

- 18 individual targeted raw milk samples collected at individual farms at the farm bulk milk tank, over the 2015/16, 2016/17 and 2017/18 dairy seasons; and
- 4 dairy product samples were collected over the 2014/15 season, and 6 in each of the 2015/16, 2016/17 and 2017/18 dairy seasons.

The dairy product samples were from a range of dairy products manufactured in New Zealand, including anhydrous milk fat, butter, cheese, and cream.

All the sampling of raw milk occurred at the farm bulk milk tank prior to any further consolidation, co-mingling or dilution with milk from other farms. All the samples were tested for dioxins, dioxin-like PCBs and some non-dioxin like PCBs (indicator PCBs) using International Accreditation New Zealand (IANZ) accredited test methods at an MPI recognised dairy laboratory.

3 European Union levels for dioxins and PCBs in food

New Zealand has not set maximum levels for dioxins and PCBs in dairy products and, along with many other countries, uses the EU maximum levels (Commission Regulation (EU) No. 1259/2011 amendment to Regulation (EC) No. 1881/2006) as a guideline for assessment of the test results. The regulation prescribes the maximum levels for dioxins, dioxin-like PCBs and non-dioxin like PCBs in foodstuffs.

Dioxins include a large number of polychlorinated dibenzo-*p*-dioxin (PCDD) and polychlorinated dibenzofuran (PCDF) congeners, only some of which are of toxicological concern. Polychlorinated biphenyls (PCBs) are another large group of different congeners which can be divided into two groups according to their toxicological properties: those with toxicological properties similar to dioxins ('dioxin-like PCBs' (DL-PCB)) and those that do not exhibit dioxin-like toxicity ('non-dioxin like PCBs' (NDL-PCB)).

Results for dioxins or dioxin-like PCBs are expressed in terms of a quantifiable unit, the TCDD toxic equivalent (TEQ) which is calculated using WHO derived toxic equivalency factors (WHO-TEFs) for human risk assessment. Appendix 6.1 sets out the WHO derived toxic equivalency factors (WHO-TEFs) for human risk assessment used to calculate the TEQ values.

The levels for non-dioxin like PCBs are reported using sum of the six marker or indicator PCBs (PCB 28, 52, 101, 138, 153 and 180). The sum is considered an appropriate marker for occurrence and human exposure to NDL-PCB.

The EU have also recommended non-binding action levels to limit the presence of dioxins and dioxin-like PCBs in food. Action levels are intended as a tool to highlight those cases where significant levels of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/Fs) above the normal background level were found and, where appropriate, to identify a source of contamination and to take measures for its reduction or elimination. These action levels are used in New Zealand.

Table 1 sets out the current EU maximum and action levels for dioxins and PCBs in foodstuffs:

Table 1: European Commission maximum levels for dioxins (the sum of PCDDs and PCDFs) and PCBs in foodstuffs (EC No 1259/2011) and recommendation on action levels for dioxins and PCBs in foodstuffs (2014/663/EU)

Food	EU action level ⁽¹⁾		EU maximum level ⁽²⁾		
	Dioxins + Furans ⁽³⁾ (WHO-TEQ) ⁽⁸⁾	Dioxin-like PCBs ⁽⁴⁾ (WHO-TEQ) ⁽⁸⁾	Sum of dioxins ⁽⁵⁾ (WHO-PCDD/F-TEQ) ⁽⁸⁾	Sum of dioxins and dioxin-like PCBs ⁽⁶⁾ (WHO-PCDD/F-PCB-TEQ) ⁽⁸⁾	Sum of indicator PCBs (ICES – 6) ^{(8) (10)}
Raw milk and dairy products, including butter fat	1.75 pg/g fat ⁽⁷⁾	2.0 pg/g fat ⁽⁷⁾	2.5 pg/g fat ⁽⁹⁾	5.5 pg/g fat ⁽⁹⁾	40 ng/g fat ⁽⁹⁾

Notes

- 1 Commission Recommendation of 11 September 2014 amending the Annex to Recommendation 2013/711/EU on the reduction of the presence of dioxins, furans and PCBs in feed and food (2014/663/EU; Official Journal of the European Union No. L 272, p. 17-18).
- 2 Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs (OJ L 320, 03/12/2011, p. 18–23).
- 3 'Dioxins + furans (WHO-TEQ)' means the sum of polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), expressed as World Health Organisation (WHO) toxic equivalent using the WHO-toxic equivalency factors (WHO-TEFs).
- 4 'Dioxin-like PCBs (WHO-TEQ)' means the sum of polychlorinated biphenyls (PCBs), expressed as WHO toxic equivalent using the WHO-TEFs
- 5 'Sum of dioxins (WHO-PCDD/F-TEQ)' means the sum of polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), expressed as WHO toxic equivalent using the WHO-toxic equivalency factors (WHO-TEFs).
- 6 'Sum of dioxins and dioxin-like PCBs (WHO-PCDD/F-PCB-TEQ)' means the sum of polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs), expressed as WHO toxic equivalent using the WHO-toxic equivalency factors (WHO-TEFs).
- 7 The action levels are not applicable for food products containing < 2 % fat.
- 8 Upper bound concentrations: Upper bound concentrations are calculated assuming that all the values of the different congeners less than the limit of quantification are equal to the limit of quantification.
- 9 The maximum level expressed on fat is not applicable for foods containing < 2 % fat. For foods containing less than 2 % fat, the maximum level applicable is the level on product basis corresponding to the level on product basis for the food containing 2 % fat, calculated from the maximum level established on fat basis, making use of following formula:
Maximum level expressed on product basis for foods containing less than 2 % fat = maximum level expressed on fat for that food x 0.02.
- 10 'ICES – 6' means International Council for the Exploration of the Seas – 6 Indicator PCBs (PCB28, PCB52, PCB 101, PCB138, PCB 153 and PCB180).

4 What we found

Table 2 provides a summary of the total number of test results over the dairy seasons:

Table 2: Total number of test results over the dairy seasons

Dairy Season	Number of test results comprising individual congener and sum of dioxins, dioxin-like PCBs, sum of dioxins and dioxin-like PCBs, and sum of the indicator PCBs	Number of test results comprising of sum of dioxins, dioxin-like PCBs, sum of dioxins and dioxin-like PCBs, and sum of the indicator PCBs
2014/15	156	16
2015/16	468	48
2016/17	468	48
2017/18	468	48

Of the sum of dioxins, dioxin-like PCBs, sum of dioxins and dioxin-like PCBs, and sum of the indicator PCBs results, there were no detections recorded as exceeding either the EU action levels (early warning system) or the EU regulatory maximum levels threshold.

The levels detected do not exceed the most appropriate science-based European Union standards for the sum of dioxins and PCBs. This means that the risk of dioxins or PCBs entering the milk supply is very low and that in this regard, the dairy products manufactured are safe and suitable for their intended purpose.

Table 3 provides a summary of dioxin and PCB results by sample type for 2014/15, 2015/16, 2016/17 and 2017/18. Appendix 6.1 sets out the WHO derived toxic equivalency factors (WHO-TEFs) for human risk assessment used to calculate the total toxic equivalence (TEQ) values.

Table 3: Summary of dioxin and PCB results by sample type and dairy season

Dairy Season	Sample Type	No. Samples Tested	Sum of dioxins (WHO-PCDD/ F-TEQ) pg/g fat		Dioxin-like PCBs (WHO-TEQ) pg/g fat	Sum of dioxins and dioxin-like PCBs (WHO-PCDD/F-PCB-TEQ) pg/g fat	Sum of indicator PCBs (ICES – 6) ng/g fat
			Above EU Action Level	Above EU Maximum Level	Above EU Action Level	Above EU Maximum Level	Above EU Maximum Level
2014/15	Anhydrous Milk Fat	1	0	0	0	0	0
	Butter	1	0	0	0	0	0
	Cheese	1	0	0	0	0	0
	Cream	1	0	0	0	0	0
	Total	4	0	0	0	0	0
2015/16	Anhydrous Milk Fat	1	0	0	0	0	0
	Butter	5	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
2016/17	Anhydrous Milk Fat	2	0	0	0	0	0
	Butter	2	0	0	0	0	0
	Cream	2	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
2017/18	Anhydrous Milk Fat	2	0	0	0	0	0
	Butter	2	0	0	0	0	0
	Cream	2	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0

Note

No detections above LOR reported above the EU regulatory action and maximum levels.

5 Conclusion

These results, in association with New Zealand's geographical isolation and relatively low level of industrialisation, support the conclusion that dairy cattle within New Zealand are not significantly exposed to dioxins and PCBs and that any levels in dairy products manufactured from New Zealand raw milk are unlikely to pose any concern relative to international action levels and/or maximum levels.

6 Appendices

6.1 WORLD HEALTH ORGANISATION DERIVED TOXIC EQUIVALENCY FACTORS FOR HUMAN RISK ASSESSMENT

Table 5: World Health Organisation derived Toxic Equivalency Factors for human risk assessment

Compound	WHO 2005 TEF
Dibenzo-p-dioxins ('PCDDs')	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Dibenzofurans ('PCDFs')	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003
'Dioxin-like' PCBs <i>Non-ortho</i> PCBs + <i>Mono-ortho</i> PCBs	
<i>Non-ortho</i> PCBs	
PCB 77	0.0001
PCB 81	0.0003
PCB 126	0.1
PCB 169	0.03
<i>Mono-ortho</i> PCBs	
PCB 105	0.00003
PCB 114	0.00003
PCB 118	0.00003
PCB 123	0.00003
PCB 156	0.00003
PCB 157	0.00003
PCB 167	0.00003
PCB 189	0.00003

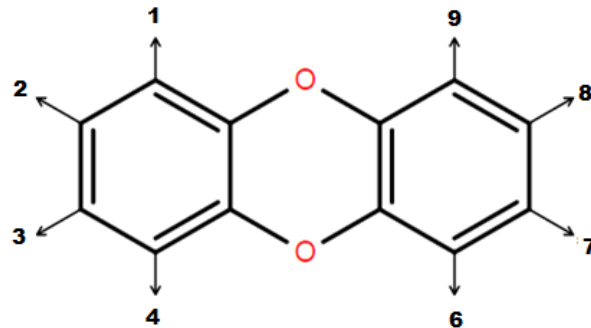
Source

Martin van den Berg et al., (2006). The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. *Toxicological Sciences* 93(2), 223–241.

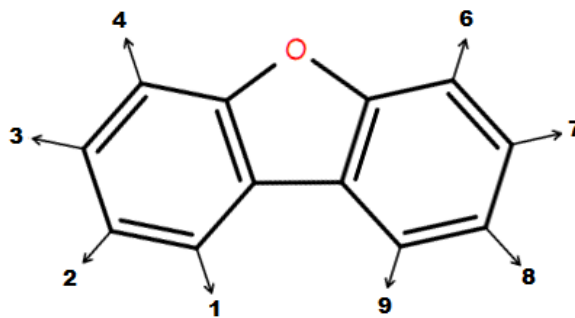
6.2 STRUCTURE AND NOMENCLATURE OF DIOXINS, FURANS AND PCBS

Figure 1: Basic structure of dioxins, furans and PCBs

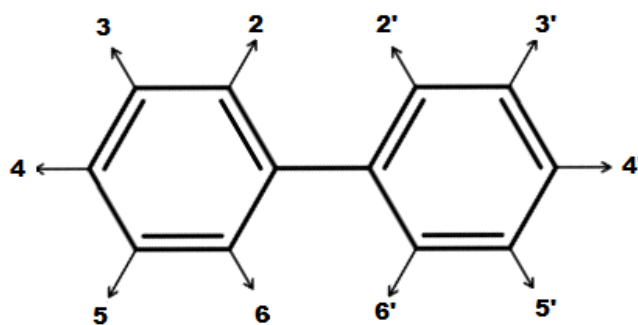
Polychlorinated dibenzo-*p*-dioxins (Dioxins) – Basic structure:



Polychlorinated dibenzofurans (Furans) – Basic structure:



Polychlorinated biphenyls (PCBs) – Basic Structure:



Nomenclature

The nomenclature of the specific dioxin, furan and PCB congener is based on the binding of chlorines to the numbering schemes. For example 2,3,7,8-Tetrachlorodibenzodioxin (TCDD) has chlorines bound to substituents 2, 3, 7 and 8. Octachlorodibenzodioxin (OCDD) has chlorines bound to all 8 available binding sites. 2,3,3',4,4',5-Hexachlorobiphenyl (PCB-156) has six chlorines bound to the sites 2, 3, 3', 4, 4' and 5.

Table 6: Congeners Tested in NCCP Programme

Compound Shorthand	Compound Full Name
Dibenzo-<i>p</i>-dioxins ('PCDDs')	
2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin
1,2,3,7,8-PeCDD	1,2,3,7,8-Pentachlorodibenzo- <i>p</i> -dioxin
1,2,3,4,7,8-HxCDD	1,2,3,4,7,8-Hexachlorodibenzo- <i>p</i> -dioxin
1,2,3,6,7,8-HxCDD	1,2,3,6,7,8-Hexachlorodibenzo- <i>p</i> -dioxin
1,2,3,7,8,9-HxCDD	1,2,3,7,8,9-Hexachlorodibenzo- <i>p</i> -dioxin
1,2,3,4,6,7,8-HpCDD	1,2,3,4,6,7,8-Heptachlorodibenzo- <i>p</i> -dioxin
OCDD	1,2,3,4,6,7,8,9-Octachlorodibenzo- <i>p</i> -dioxin
Dibenzofurans ('PCDFs')	
2,3,7,8-TCDF	2,3,7,8-Tetrachlorodibenzofuran
1,2,3,7,8-PeCDF	1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-PeCDF	2,3,4,7,8-Pentachlorodibenzofuran
1,2,3,4,7,8-HxCDF	1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-HxCDF	1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-HxCDF	1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-HxCDF	2,3,4,6,7,8-Hexachlorodibenzofuran
1,2,3,4,6,7,8-HpCDF	1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-HpCDF	1,2,3,4,7,8,9-Heptachlorodibenzofuran
OCDF	1,2,3,4,6,7,8,9-Octachlorodibenzofuran
'Dioxin-like' PCBs (Non-ortho PCBs + Mono-ortho PCBs)	
<i>Non-ortho PCBs</i>	
PCB 77	3,3',4,4'-Tetrachlorobiphenyl
PCB 81	3,4,4',5-Tetrachlorobiphenyl
PCB 126	3,3',4,4',5-Pentachlorobiphenyl
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl
<i>Mono-ortho PCBs</i>	
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl
PCB 114	2,3,4,4',5-Pentachlorobiphenyl
PCB 118	2,3',4,4',5-Pentachlorobiphenyl
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl