New Zealand Food Safety

Haumaru Kai Aotearoa

National Chemical Contaminants Programme

Dairy products and raw milk

Dioxin, dioxin-like PCB, and non-dioxin like polychlorinated biphenyls (indicator PCBs) results (2014/15- 2023/24)

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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 - 2023/24 dairy seasons.

Dioxins and PCBs can be 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, occur globally, 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 NCCP surveys for these contaminants. This programme monitors dairy products and milk for dioxins and PCBs which is undertaken annually 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 for the sum of dioxins and PCBs do not exceed the most appropriate science-based overseas standards. 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 Legal framework

Dairy monitoring and surveillance programmes for substances of interest have been in operation in New Zealand for many years and a national programme for the monitoring of raw milk was introduced in the 1996/97 dairy season.

The NCCP is an official programme under the Animal Products Act¹ and supported by various regulations and notices, including the Animal Products Regulations 2021² and the Animal Products Notice: Sampling Regimes for Monitoring³. The NCCP is administered by New Zealand Food Safety, which is a business unit of the Ministry for Primary Industries.

3 Programme design

Dairy product samples are obtained under the supervision of a recognised person⁴ at a manufacturers' premises. Raw milk samples are collected at individual farms at the farm bulk milk tank. Some of these samples are targeted to regions with industrial processes which may result in dioxins as well as at least one region with no knowledge of any industrial processes occurring. The samples are tested at an MPI recognised laboratory, using ISO/IEC 17025 accredited test methods. The results of this programme, along with the other NCCP monitoring programmes provides confidence in the safety and suitability of New Zealand dairy products.

4 Sampling and testing

- 53 individual targeted raw milk samples collected at individual farms at the farm bulk milk tank, over the 2015/16, 2016/17, 2017/18, 2018/19, 2019/20, 2020/21, 2021/22, 2022/23 and 2023/24 dairy seasons; and
- 4 dairy product samples were collected over the 2014/15 season, and 6 in each of the 2015/16, 2016/17, 2017/18, 2018/19, 2019/20, 2020/21, 2021/22, 2022/23 and 2023/24 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.

¹ Animal Products Act 1999 No 93 (as at 06 April 2023), Public Act – New Zealand Legislation

² Animal Products Regulations 2021 (SL 2021/400) (as at 06 October 2022) – New Zealand Legislation

³ <u>Sampling Regimes for Monitoring – Animal Product Notice (mpi.govt.nz)</u>

⁴ https://www.mpi.govt.nz/legal/approved-organisations-and-people/animal-products-act-recognised-agencies-and-

persons/apa-recognised-agencies/APA recognised agencies | NZ Government (mpi.govt.nz)

All the sampling of raw milk occurred at the farm bulk milk tank prior to any further consolidation, comingling 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 ISO/IEC 17025 accredited test methods at an MPI recognised laboratory.

5 European Union levels for dioxins and PCBs in food

New Zealand has not set maximum levels for dioxins and PCBs in dairy products and milk and along with many other countries, uses the European Union (EU) maximum levels (Commission Regulation (EU) 2023/915) 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, 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. The WHO-TEFs account for the specific toxic potency of each congener relative to that of 2,3,7,8-tetracholorodibenzo-*p*-dioxin (2,3,7,8-TCDD). Table 4 sets out the 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-PCB⁵.

The EU has also recommended non-binding action levels to limit the presence of dioxins and dioxinlike PCBs in food. Action levels are intended as a tool to highlight those cases where significant levels of PCDDs and PCDD/Fs (polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans) 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 EU action levels are applied to testing carried out under this programme.

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

	EU action level (1)		EU maximum level (2)		
Food	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 non dioxin-like PCBs (ICES – 6) ^{(8) (10)}
Raw milk and dairy products, including butter fat	1.75 pg/g fat ⁽⁷⁾	2.00 pg/g fat ⁽⁷⁾	2.0 pg/g fat ⁽⁹⁾	4.0 pg/g fat ⁽⁹⁾	40 ng/g fat ⁽⁹⁾

Table 1: European Commission maximum levels for dioxins (the sum of PCDDs and PCDFs) and PCBs in foodstuffs (EU No 2023/915) and recommendation on action levels for dioxins and PCBs in foodstuffs (2014/663/EU)

Note:

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).

Commission Regulation (EU) 2023/915 on maximum levels for certain contaminants in food and repealing Regulation (EC) No 1881/2006.
 '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).

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),

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).

⁵ EUR-Lex - 02023R0915-20230810 - EN - EUR-Lex (europa.eu)

- 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).

6 Results

Table 2 provides a summary of the 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
2018/19	468	48
2019/20	468	48
2020/21	468	48
2021/22	468	48
2022/23	468	48
2023/24	429	44

Table 2: Total number of test results over the dairy seasons (2014/15 – 2023/24)

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. Some low-level results are reported.

The levels detected do not exceed the science-based European Union standard for the sum of dioxins and PCBs. This means that the risk of dioxins or PCBs entering the New Zealand 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 PCDD/F and PCB results by sample type for each sampling year. Table 4 sets out the WHO-TEFs for human risk assessment used to calculate the TEQ values.

Table 3: Summary of dioxin and PCB results by sample type and dairy season (2014/15 – 2023/24)

Dairy season	Sample type	Number of samples tested	Sum of dioxins + furans (WHO- TEQ) pg/g fat	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 non dioxin-like 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
	Anhydrous Milk Fat	1	0	0	0	0	0
	Butter	1	0	0	0	0	0
2014/15	Cheese	1	0	0	0	0	0
	Cream	1	0	0	0	0	0
	Total	4	0	0	0	0	0
	Anhydrous Milk Fat	1	0	0	0	0	0
2015/16	Butter	5	0	0	0	0	0
	Milk	6	0	0	0	0	0
		12	0	0	0	0	0
2016/17	Annydrous Milk Fat	2	0	0	0	0	0
2010/11	Green	2	0	0	0	0	0
	Milk	6	0	0	0	0	0
		12	0	0	0	0	0
	Anhydrous Milk Fat	2	0	0	0	0	0
0047/40	Butter	2	0	0	0	0	0
2017/18	Cream	2	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
	Anhydrous Milk Fat	5	0	0	0	0	0
2018/19	Butter	1	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
	Anhydrous Milk Fat	6	0	0	0	0	0
2019/20	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
2020/21	Anhydrous Milk Fat	6	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
2021/22	Anhydrous Milk Fat	6	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
2022/23	Anhydrous Milk Fat	6	0	0	0	0	0
	Milk	6	0	0	0	0	0
	Total	12	0	0	0	0	0
2023/24	Anhydrous Milk Fat	6	0	0	0	0	0
	Milk	5*	0	0	0	0	0
	Total	11	0	0	0	0	0

Note:

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

Table key:

- Maximum levels refer to upper bound concentrations, which are calculated on the assumption that all the values of the different congeners below the limit of quantification are equal to the limit of quantification.
- * One milk sample in the 2023/24 NCCP survey was not able to be tested due to a sample integrity issue identified upon receipt at the laboratory.

7 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 does not pose any concern relative to international action levels and/or maximum levels.

8 Appendices

8.1 World Health Organisation derived Toxic Equivalency Factors for human risk assessment

Table 4: 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 Non-ortho PCBs + Mono-ortho PCBs				
Non-ortho PCBs				
PCB 77	0.0001			
PCB 81	0.0003			
PCB 126	0.1			
PCB 169	0.03			
Mono-ortho PCBs				
PCB 105	0.00003			
PCB 114	0.00003			

Compound	WHO 2005 TEF
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.

8.2 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:





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.

Compound Shorthand	Compound Full Name			
Dibenzo-n-dioxins ('PCDDs')				
2.3.7.8-TCDD	2.3.7.8-Tetrachlorodibenzo-p-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-p-dioxin			
1,2,3,6,7,8-HxCDD	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin			
1,2,3,7,8,9-HxCDD	1,2,3,7,8,9-Hexachlorodibenzo-p-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-p-dioxin			
	2.3.7.8-Tetrachlorodihenzofuran			
1 2 3 7 8-PeCDE	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-HyCDF	1,2,3,6,7,8,Heyachlorodibenzofuran			
123789-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)				
Non-ortho PCBs				
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			
Mono-ortho PCBs				
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl			
PCB 114	2,3,4,4',5-Pentachlorobiphenyl			

Table 5: Congeners Tested in NCCP Programme

Compound Shorthand	Compound Full Name
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
Non dioxin-like PCBs (indicator PCBs)	
PCB 28	2,4,4'-Trichlorobiphenyl
PCB 52	2,2',5,5'-Tetrachlorobiphenyl
PCB 101	2,2',4,5,5'-Pentachlorobiphenyl
PCB 138	2,2',3',4,4',5-Hexachlorobiphenyl
PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl
PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl