New Zealand Food Safety

Haumaru Kai Aotearoa

National Chemical Contaminants Programme

Milk and milk powder
Radionuclide results (2013/14, 2014/15, 2015/16 & 2016/17)

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Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
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Telephone: 0800 00 83 33
Facsimile: 04-894 0300

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1 Summary

This National Chemical Contaminants Programme report provides results for radionuclides in a range of milk and milk powders, sampled over the 2013/14, 2014/15, 2015/16 and 2016/17 dairy seasons. This report will be updated with results for subsequent years, as those results become available.

New Zealand's lack of nuclear facilities and geographical isolation in the south of the Pacific Ocean results in it being one of the countries that is least affected by anthropogenic radionuclide contamination. Nevertheless, to satisfy international certification requirements New Zealand milk powders are routinely monitored for anthropogenic radionuclide contamination in conjunction with the national survey undertaken by the National Centre for Radiation Science. Routine monitoring includes the nuclear fission product caesium-137, as well as the transuranics plutonium-239/240 and americium-241. Monitoring may also include iodine-131, caesium-134 and strontium-90. Additional radionuclide testing may be undertaken on occasion to meet the requirements of particular markets.

The monitoring results continue to confirm the suitability of existing production and processing practices and the suitability of the New Zealand environment with respect to ensuring New Zealand dairy products meet international radionuclide standards.

2 What we tested

A total of 122 dairy milk powder samples and 13 liquid milk samples have been tested over the 2013/14, 2014/15, 2015/16 and 2016/17 dairy seasons. Liquid milk samples are tested for the presence of gamma isotopes (I-131, Cs-134, Cs-137) when milk powder availability is low during the June and July period. These samples were collected from manufacturers in three New Zealand regions (Waikato, Taranaki and Westland).

Results for I-131, Cs-134, Cs-137, Pu-239/240 and Am-241 were reported under the testing laboratory's scope of accreditation. Sr-90 results were also reported.

3 What we found

3.1 RADIONUCLIDE ACTIVITY

Of the 726 individual radioactivity content test results, all radionuclides were reported below the calculated minimum detectable activity limits except for Cs-137 which was the only detectable anthropogenic radionuclide. The radionuclides analysed that were below the minimum detectable activity are presented in Table 1.

Table 1: Radionuclides analysed that were below minimum detectable activity in milk and milk powder

Radionuclide	Decay type	Half-life#	Analysis method	Average MDA (Bq/kg)
Strontium-90 (Sr-90)	β-	28.8 y	Liquid scintillation counting	1.69
Iodine-131 (I-131)	β-	8.0 d	γ spectroscopy	0.31
Caesium-134 (Cs-134)	β-	2.1 y	γ spectroscopy	0.38
Plutonium-239 (Pu-239)	α	2.4×10^4 y	α spectrometry	0.07*
Plutonium-240 (Pu-240)	α	6563 y	α spectrometry	0.07*
Americium-241 (Am-241)	α	432 y	α spectrometry	0.07

Notes
d: days; y: years
* Pu-239 and Pu-240 activities are reported as a sum of both isotopes.

Table 2 provides a summary of annual average quantified Cs-137 activity concentrations in milk and milk powder over the 2013/14, 2014/15, 2015/16 and 2016/17 dairy seasons. Appendix 1 includes all the results (detections above and below the calculated minimum detectable activity limits) by year and region for Cs-137.

Table 2: Annual average Cs-137 activity concentrations in milk and milk powder

Region	Cs-137 ± 2σ Uncertainty (Bq/kg)*			
	Annual average 2013/14	Annual average 2014/15	Annual average 2015/16	Annual average 2016/17
Waikato	0.41 ± 0.10	0.45 ± 0.21	0.48 ± 0.24	0.59 ± 0.06
Taranaki	0.71 ± 0.20	0.88 ± 0.22	0.97 ± 0.32	0.84 ± 0.17
Westland	0.26 ± 0.13	0.28 ± 0.05	0.24 ± 0.08	0.12 ± 0.04
New Zealand	0.48 ± 0.14	0.61 ± 0.22	0.74 ± 0.22	0.68 ± 0.26

Note
* This is the average of samples with results above the minimum detectable activity only.

The Cs-137 detections are very close to the calculated minimum detectable activity limits (refer Appendix 1) and are far below levels that would give rise to health concerns. The results indicate that the dairy products manufactured are safe and wholesome.

3.2 INTERPRETATION OF RESULTS

Codex Alimentarius sets guideline levels for use following a nuclear accident (Table 3).

Table 3: Codex Alimentarius guideline levels for radionuclides

Product name	Representative radionuclides	Level (Bq/kg)*
Infant food	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am	1
Infant food	^{90}Sr, ^{106}Ru, ^{129}I, ^{131}I, ^{235}U	100
Infant food	^{35}S, ^{60}Co, ^{89}Sr, ^{103}Ru, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{192}Ir	1000
Infant food	^{3}H, ^{14}C, ^{99}Tc	1000
Foods other than infant foods	^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am	10
Foods other than infant foods	^{90}Sr, ^{106}Ru, ^{129}I, ^{131}I, ^{235}U	100
Foods other than infant foods	^{35}S, ^{60}Co, ^{89}Sr, ^{103}Ru, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{192}Ir	1000
Foods other than infant foods	^{3}H, ^{14}C, ^{99}Tc	10000

Note
* Guideline levels apply to the sum of activities from representative radionuclides, and to a food after reconstitution or preparation for consumption.

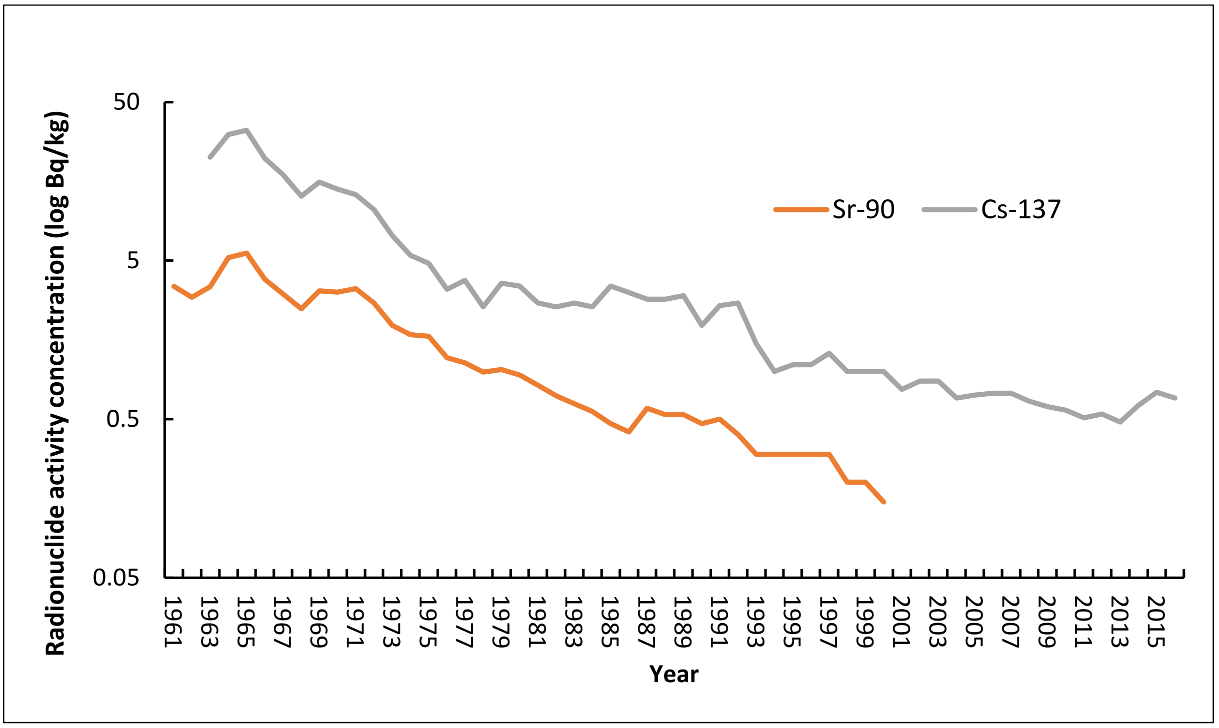
The monitoring for the range of radionuclides listed on Table 3 is applicable only when exposure may have occurred following a nuclear accident. The International Commission on Radiation Protection (ICRP) dose reference level of 1 milliSievert (µSv) per year is used as a suitable health based guidance value to inform the acceptability of a source of dietary ionising radiation exposure to the general public. The Codex Alimentarius guideline levels are based on not exceeding this dose level from a food constituting 10% of the diet.

A conservative calculation can be made of the contribution the activity concentrations of Cs-137 make to the dietary ionising radiation dose. The ICRP dose conversion coefficients for Cs-137 are used to convert the ingested activity concentration, in Bq/kg, into a daily dose of Sieverts per kg of milk powder. Intake of milk is assigned to the standardised liquid milk intake of 1.5 L per day used in international modelling of veterinary drug intakes (EHC 240). Finally, the result is multiplied by 365 to represent a year's consumption.

Using the maximum activity concentration reported in New Zealand milk powder (1.56 Bq/kg) and converting this to the liquid milk equivalent, the resulting calculation derives a dose of 1.1 µSv per year for children and 1.5 µSv per year for adults. This is 0.11-0.15% respectively of the ICRP dose reference level. This confirms that the doses of ionising radiation received through the trace activity concentrations of Cs-137 present in New Zealand dairy product are a negligible risk to health.

In the absence of a domestic nuclear industry, the legacy contamination from international atmospheric nuclear testing is the highest contributor to New Zealand's anthropogenic radionuclide levels. Cs-137 has been monitored in milk since the 1950s in New Zealand and is seen as the best model for mid- to long-lived nuclear fission products released from atmospheric nuclear testing. Some small variations in Cs-137 activity concentrations can occur year to year as changes in weather and feeding practices result in different intakes of the radionuclide by animals. Additionally, there is proportionally higher variation as Cs-137 activity concentrations are close to the calculated minimum detectable activity limits for the method. However, based upon long-term trends, the detections reported over the testing period covered by this report are consistent with the gradual pattern of decline of Cs-137 since the 1950s, through both radioactive decay, and becoming unavailable for food chain uptake in soil (Figure 1). In reconstituted milk, the activity concentrations detected would be approximately 10000 fold below the Codex guideline level for Cs-137.

Figure 1: Trends in the New Zealand annual average of detected Sr-90 and Cs-137 activity concentrations in milk powder between 1961 and 2016



Sr-90 was monitored by the National Centre for Radiation Science (formerly National Radiation Laboratory) until 2000 after which activity concentrations had decayed below the minimum detectable concentration. However, ongoing monitoring remains in place to meet trade obligations.

MPI and the Institute of Environmental Science and Research (ESR) have recently published[1] a study on dietary levels of radionuclides. The study concluded that, based on the established activity concentrations and ranges, the New Zealand diet contains activity concentrations of anthropogenic radionuclides far below the Codex Alimentarius guideline levels. In addition, the activity concentrations obtained for milk powder, support its continued use as a sentinel for monitoring fallout radionuclides in terrestrial agriculture.

4 Conclusion

These results confirm that a range of milk powders manufactured in New Zealand fall well within the guideline limits for radionuclides applied internationally. This indicates that New Zealand dairy products conform to both consumer expectations and international regulatory requirements.

[1] Pearson, A.J., et al., Natural and anthropogenic radionuclide activity concentrations in the New Zealand diet, Journal of Environmental Radioactivity (2015), http://dx.doi.org/10.1016/j.jenvrad.2015.05.022

5 Appendix 1

5.1 RESULTS FOR Cs-137 BY MONTH AND REGION

Table 4: Detections by month and region

Location: Waikato		
Month and year	**^{137}Cs (Bq/kg)**	**± 2 s (Bq/kg)**
July '13	< 0.15	-
August '13	< 0.49	-
September '13	0.27	0.11
October '13	0.38	0.12
November '13	< 0.37	-
December '13	< 0.59	-
January '14	0.28	0.12
February '14	0.53	0.15
March '14	0.51	0.19
April '14	0.41	0.13
May '14	0.47	0.18
June '14	< 0.18	-
July '14	< 0.19	-
August '14	< 0.52	-
September '14	< 0.47	-
October '14	0.20	0.11
November '14	< 0.60	-
December '14	0.40	0.13
January '15	0.68	0.15
February '15	0.79	0.26
March '15	0.25	0.10
April '15	< 0.57	-
May '15	0.36	0.18
June '15	< 0.21	-
July '15	< 0.17	-
August '15	-	-
September '15	0.32	0.19
October '15	< 0.54	-
November '15	< 0.42	-
December '15	< 0.35	-
January '16	0.75	0.25
February '16	0.31	0.18
March '16	0.52	0.21
April '16	< 0.38	-
May '16	-	-
June '16	-	-
July '16	< 0.16	-
August '16	0.54	0.21
September '16	< 0.50	-
October '16	< 0.43	-
November '16	-	-

Location: Waikato		
Month and year	^{137}Cs (Bq/kg)	± 2 s (Bq/kg)
December '16	< 0.52	-
January '17	0.59	0.19
February '17	0.63	0.19
March '17	< 0.38	-
April '17	< 0.32	-
May '17	-	-
June '17	< 0.16	-

Location: Taranaki		
Month	^{137}Cs (Bq/kg)	± 2 s (Bq/kg)
July '13	< 1.17	-
August '13	0.37	0.14
September '13	0.44	0.15
October '13	0.64	0.18
November '13	0.75	0.25
December '13	0.83	0.22
January '14	0.75	0.25
February '14	0.98	0.20
March '14	0.82	0.24
April '14	0.93	0.21
May '14	0.60	0.19
June '14	< 0.23	-
July '14	< 0.20	-
August '14	0.30	0.16
September '14	0.47	0.19
October '14	0.69	0.15
November '14	0.87	0.18
December '14	1.32	0.34
January '15	1.03	0.24
February '15	1.17	0.27
March '15	1.05	0.27
April '15	1.15	0.25
May '15	0.74	0.19
June '15	< 0.0052	-
July '15	< 0.17	-
August '15	0.22	0.11
September '15	-	-
October '15	0.87	0.23
November '15	0.64	0.21
December '15	0.51	0.20
January '16	1.15	0.24
February '16	1.56	0.32
March '16	1.48	0.27
April '16	1.32	0.25
May '16	1.00	0.26
June '16	-	-
July '16	< 0.19	-

Location: Taranaki		
Month	**^{137}Cs (Bq/kg)**	**± 2 s (Bq/kg)**
August '16	0.31	0.12
September '16	0.77	0.19
October '16	0.82	0.18
November '16	0.75	0.17
December '16	0.84	0.21
January '17	-	-
February '17	1.10	0.25
March '17	1.10	0.24
April '17	0.91	0.24
May '17	0.94	0.22
June '17	< 0.097	-

Location: Westland		
Month	**^{137}Cs (Bq/kg)**	**± 2 s (Bq/kg)**
July '13	< 0.37	-
August '13	< 0.42	-
September '13	0.12	0.079
October '13	0.21	0.12
November '13	0.12	0.091
December '13	0.26	0.12
January '14	0.33	0.15
February '14	0.28	0.11
March '14	0.28	0.14
April '14	0.45	0.16
May '14	< 0.16	-
June '14	< 0.40	-
July '14	< 1.1	-
August '14	< 0.35	-
September '14	< 0.27	-
October '14	< 0.47	-
November '14	0.21	0.072
December '14	0.36	0.075
January '15	0.29	0.11
February '15	0.30	0.08
March '15	0.27	0.077
April '15	< 0.25	-
May '15	< 0.37	-
June '15	< 0.59	-
July '15	< 0.39	-
August '15	< 0.34	-
September '15	< 0.37	-
October '15	0.21	0.073
November '15	< 0.45	-
December '15	< 1.5	-
January '16	< 0.80	-
February '16	< 0.38	-
March '16	< 0.48	-

Location: Westland		
Month	**^{137}Cs (Bq/kg)**	**± 2 s (Bq/kg)**
April '16	< 0.30	-
May '16	< 0.26	-
June '16	0.27	-
July '16	-	-
August '16	0.130	0.095
September '16	< 0.36	-
October '16	< 0.44	-
November '16	< 0.43	-
December '16	< 0.36	-
January '17	< 0.30	-
February '17	< 0.32	-
March '17	< 0.25	-
April '17	< 0.33	-
May '17	< 0.31	-
June '17	0.101	0.087