Australian Milk Residue Analysis Survey

Annual Report 2023–24

The Australian Milk Residue Analysis (AMRA) Survey is the independent chemical residue monitoring program for bovine milk, delivered for the Australian Government Department of Agriculture, Fisheries and Forestry and State Regulatory Authorities:

Australian Government Department of Agriculture, Fisheries and Forestry | NSW Food Authority | safe food queensland | Dairy Food Safety Victoria | TDIA | DAIRYSAFE | Government of Western Australia Department of Health Public Health and Clinical Services

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Executive summary

The AMRA Survey (the Survey) is the national residue monitoring program for agricultural and veterinary chemicals and environmental contaminants in bovine milk. The Survey supports the export requirements of the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) under the *Export Control (Milk and Milk Products) Rules 2021*[1].

The Survey is funded through DAFF, who also approve the sampling plan. Dairy Food Safety Victoria (DFSV) co-ordinates the Survey.

The Survey is a risk-based program designed to identify and monitor residues from chemical inputs in the Australian milk supply chain. It verifies the effectiveness of the control measures in place to ensure appropriate food safety outcomes and provides assurance to consumers both in Australia and overseas regarding the safety and quality of Australian dairy products.

The Survey tests randomly selected raw milk samples for a range of residues. Samples are taken from all dairying regions and the number collected is commensurate with milk production volumes in each region.

For the 2023-24 Survey, 1029 milk samples were collected and 14,616 analyses were conducted. Of the samples tested, 100% complied with Australian residue standards.

Setting of Australian residue standards

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is the federal authority responsible for the evaluation and registration of agricultural and veterinary chemicals (agvet chemicals) for supply, sale and use in Australia. The APVMA assesses and approves agvet chemicals for use and sets maximum residue limits (MRLs) applying to both imported and domestic food. MRLs are listed in the *Australia New Zealand Food Standards Code* (ANZFSC)[2] following consideration by Food Standards Australia New Zealand (FSANZ).

The APVMA also sets extraneous residue limits (ERLs). These are the maximum permitted limits of pesticide residues in food commodities arising from environmental sources.

A maximum level (ML) is the level of a specified contaminant or natural toxicant which is permitted to be present in a food and applies to chemicals such as heavy metals and mycotoxins[2]. These are listed in the ANZFSC[2].

The ANZFSC[2] specifies that where no MRL or ERL has been established for a particular agricultural or veterinary chemical residue in a particular food, there must be no detectable level of that residue present. In contrast, where no ML has been set for a particular environmental contaminant in a food, residues are allowable at low levels.

Survey design and sample collection

The Survey design is risk-based and reflective of the agricultural practices in the Australian dairy industry. Samples are taken from all dairying states commensurate with milk production volumes in each region. The European Union (EU) residue monitoring directives are used to provide a framework for the design of the survey. The compounds selected for analysis represent agricultural and veterinary chemical use patterns in Australian dairy production and other chemicals that may be of interest to Australia's trading partners.

All samples are taken randomly throughout the twelve-month period on a nationwide basis. There are stratified components within the random selection for certain types of samples based on defined geographic areas and both seasonal and historical usage patterns. Samples with stratified components were analysed for triclabendazole residues. All other milk samples (allocated on a random basis) were analysed for antimicrobials, amphenicols, benzimidazoles, levamisole, aflatoxin M1, macrocyclic lactones, organochlorines, organophosphates, synthetic pyrethroids, non-steroidal anti-inflammatory drugs and chemical elements. The number of samples tested and the analyses examined for the 2023–24 AMRA Survey are listed in Appendix 2.

If a residue is detected in a sample, the laboratory immediately notifies DFSV. DFSV informs the relevant State Regulatory Authority (SRA) and DAFF. The level of action is set at ≥ 50% of the Australian or EU MRL/ERL (whichever is the most stringent) or at any level in the case where no MRL/ERL has been established. If the residue is identified at or above the level of action the SRA, in cooperation with DAFF and the relevant dairy company, identifies the farms that contributed milk to the tanker load. Individual milk samples from each farm supplying the tanker are tested to determine the source of the residue. Once the supplying farm or farms have been identified, further investigations are undertaken to establish the cause of the detection. Corrective and preventative actions are implemented by the dairy company to ensure that dairy products with residues greater than the Australian or EU Standard do not enter the respective markets.

All aspects of the Survey are subject to audit by DAFF and governments of importing countries. SRAs are responsible for verifying that corrective and preventative activities have been undertaken.

Annual Review

The risk profile of various agricultural, veterinary and environmental contaminants is reviewed annually by representatives from the manufacturing and farming sector, Dairy Australia, SRAs and DAFF. The review focuses on emerging chemical residue risks, shifts in chemical use patterns and potential trends. It also identifies areas for improvement within the survey.

Proficiency Testing

All survey samples are tested by contracted laboratories accredited by the National Association of Testing Authorities (NATA). The laboratories are required to participate in the Milk Laboratory Performance Evaluation Program to verify their on-going competency and be recognised as proficient to provide testing for the Survey. The Milk Laboratory Performance Evaluation Program for the Survey is provided by the National Residue Survey (NRS), which is accredited by NATA as a Proficiency Testing Scheme Provider

Compounds tested

The Survey includes a range of residue groups including antimicrobials, endoparasiticides, ectoparasiticides, feed and environmental contaminants. The test methods used and the requirements for laboratory approval are detailed in Appendix 3.

Amphenicols

In Australia, chloramphenicol, florfenicol and thiamphenicol are currently not registered for use on dairy cattle. Amphenicols are therefore considered to pose a low risk in the Australian dairy risk profile.

Twenty-nine random samples were analysed nationally for these residues to verify that off-label use is not occurring.

Antimicrobials

Many antimicrobials, excluding chloramphenicol, are registered for use on dairy cattle in Australia and form part of good agricultural practice for managing bacterial infections in livestock. Three hundred milk samples were randomly selected for antimicrobial residues across all dairying states. Each of these milk samples was tested for 24 antimicrobial compounds.

Animal parasite control chemicals

Benzimidazoles, levamisole and macrocyclic lactones are important endoparasiticides and may be routinely used on Australian dairy farms in accordance with good agricultural practices. Macrocyclic lactones are the most commonly used group of endoparasiticides. A total of 320 random samples were collected nationally (and tested for these residues (230 macrocyclic lactones, 70 benzimidazoles and 20 levamisole).

Triclabendazole is another endoparasiticide which is predominately used in southern parts of Australia during particular times of the year. Thirty samples were randomly sampled from these parts of Australia and monitored for this compound.

In accordance with good agricultural practice, organophosphates and synthetic pyrethroids contained in registered veterinary products are used on cattle for external parasite control in Australia. A total of 230 random samples were collected nationally and tested for organophosphate and synthetic pyrethroid residues.

Feed contaminants

Organophosphates and synthetic pyrethroids are also used for insect control on harvested and stored food crops such as grains. Feed contaminants may enter the milk supply chain via the use of these feeds. Therefore, samples collected for monitoring the use of animal parasite control also monitor feed contaminants.

Due to Australia's variable climate, drought conditions are common in some areas. Pasture based feeding often becomes less sustainable in times of drought, resulting in the growing use of supplementary feed for dairy cattle. Some feeds may pose a higher risk of aflatoxin B1 contamination, for examples, peanut by-products, maize and sorghum. Drought stressed crops and high humidity may also favour the growth of *Aspergillus* moulds and the production of aflatoxins. Ingestion of feeds containing aflatoxin B1 by cattle can result in the toxins being converted and excreted as aflatoxin M1 in milk. Thirty milk samples were tested randomly for the presence of aflatoxin M1 during the 2023–24 year.

Environmental contaminants

Organochlorine pesticides are no longer registered for use in Australia, however they are known to persist in the environment for extended periods. From time-to-time cattle may ingest soil containing residues of organochlorines. Thirty random samples were taken and analysed for the presence of organochlorine residues.

Chemical elements such as arsenic and heavy metals enter the environment via several different pathways. Industrial processes and smoke emissions all contribute to the presence of these elements in the environment. Cattle grazing in such areas may excrete residues of heavy metals in milk. Thirty random samples were analysed nationally and analysed for compounds of arsenic, cadmium, mercury and lead.

Anti-inflammatory treatments

Non-steroidal anti-inflammatory drugs (NSAIDs) may be used to reduce inflammation and to provide pain relief in dairy cattle due to infections such as mastitis. Four compounds within the NSAIDs group are currently registered for use in Australia on dairy cattle. Phenylbutazone and oxyphenbutazone are not registered for use on dairy cattle but are included to verify that off-label use is not occurring in Australia.

Thirty random samples were collected and analysed for residues of flunixin, meloxicam, ketoprofen, tolfenamic acid, phenylbutazone and oxyphenbutazone.

Report on results

Summary of results

Results for the 2023–24 Survey are shown in Table 1.

During 2023–24, 1029 milk samples were collected and a total of 14,616 analyses performed. No residues were identified above the relevant Australian standard. A total of 1030 samples were scheduled for collection; however one sample missed the cut-off submission date and instead will be captured in next year's reporting.

A low level of ivermectin was detected in one sample, below 50% of the Australian MRL. Follow up investigation was conducted for EU export purposes. The trace back investigation identified the farm and confirmed that the treatment was used in accordance with label directions.

Table 1 AMRA Survey sample results 2023-24

Compound or Analyte Residue	Number of samples		Level of Action[#] (µg/kg)	Number of detections at or above Level of Action	Australian Standard[*] (µg/kg)	Number of results above AU Standard
	Planned	Tested				
Amphenicols						
Chloramphenicol	30	29[+]	AD	0	Not set	0
Florfenicol	30	29[+]	AD	0	Not set	0
Florfenicol amine	30	29[+]	AD	0	Not set	0
Thiamphenicol	30	29[+]	AD	0	Not set	0
Antimicrobials						
B-lactams						
Benzyl G Penicillin	300	300	1	0	1.5	0
Cloxacillin	300	300	10	0	10	0
Ampicillin	300	300	4	0	10	0
Amoxicillin	300	300	4	0	10	0
Cephalosporins						
Ceftiofur	300	300	50	0	100	0
Cefuroxime	300	300	20	0	100	0
Cephalonium	300	300	10	0	20	0
Cephapirin	300	300	5	0	10	0
Cephazolin	300	300	AD	0	Not set	0
Tetracyclines						
Tetracycline	300	300	50	0	100	0
Oxytetracycline	300	300	50	0	100	0
Chlortetracycline	300	300	AD	0	Not set	0
Sulfonamides						
Sulfadiazine	300	300	50	0	100	0
Sulfadimidine	300	300	AD	0	Not set	0
Sulfadoxine	300	300	50	0	100	0
Sulfatroxazole	300	300	50	0	100	0
Macrolides						
Erythromycin	300	300	40	0	40	0
Lincomycin	300	300	50	0	20	0
Oleandomycin	300	300	AD	0	Not set	0
Tylosin	300	300	50	0	50	0
Tilmicosin	300	300	AD	0	Not set	0
Aminoglycosides						
Streptomycin & Dihydrostreptomycin	300	300	100	0	200	0
Neomycin	300	300	750	0	1500	0
Gentamycin	300	300	AD	0	Not set	0
Endoparasiticides and Ectoparasiticides						
Triclabendazole	30	30	5	0	10	0
Benzimidazoles						
Albendazole	70	70	AD	0	Not set	0
Fenbendazole	70	70	5	0	100	0
Oxfendazole	70	70	5	0	100	0
Febantel	70	70	AD	0	Not set	0
Thiabendazole	70	70	25	0	50	0
Clorsulon	70	70	8	0	1500	0
Nitroxynil	70	70	10	0	500	0
Mebendazole	70	70	5	0	20	0
Monepantel	70	70	5	0	50	0
Praziquantel	70	70	AD	0	Not set	0
Levamisole	20	20	5	0	300	0

Compound or Analyte Residue	Number of samples		Level of Action[#] (µg/kg)	Number of detections at or above Level of Action	Australian Standard[*] (µg/kg)	Number of results above AU Standard
	Planned	Tested				
Endoparasiticides and Ectoparasiticides						
Macrocyclic Lactones						
Ivermectin	230	230	5	1^	50	0
Abamectin	230	230	5	0	20	0
Doramectin	230	230	5	0	50	0
Moxidectin	230	230	500F	0	2000F	0
Eprinomectin	230	230	10	0	30	0
Ectoparasiticides and Feed Contaminants						
Organophosphates						
Bromophos-ethyl	230	230	AD	0	Not set	0
Chlorpyriphos	230	230	100F	0	200F	0
Chlorpyriphos-methyl	230	230	25F	0	50F	0
Chlorfenvinphos	230	230	100F	0	200F	0
Coumaphos	230	230	80F	0	10	0
Dichlorvos	230	230	2	0	10	0
Diazinon	230	230	250F	0	500F	0
Ethion	230	230	125F	0	500F	0
Fenchlorphos	230	230	AD	0	Not set	0
Fenitrothion	230	230	30F	0	50F	0
Fenthion	230	230	AD	0	Not set	0
Malathion (Maldison)	230	230	250F	0	1000F	0
Parathion-methyl	230	230	AD	0	Not set	0
Pirimiphos-methyl	230	230	5	0	50	0
Synthetic Pyrethroids						
Deltamethrin	230	230	25	0	50	0
Flumethrin	230	230	15	0	50	0
Permethrin	230	230	25	0	50	0
Cypermethrin	230	230	500F	0	1000F	0
Fenvalerate	230	230	20	0	200	0
Cyfluthrin	230	230	10	0	100	0
Cyhalothrin	230	230	250F	0	500F	0
Mycotoxins						
Aflatoxin M1	30	30	0.05	0	-	0
Anti-inflammatory Treatments						
Non-steroidal Anti-inflammatory Drugs						
Flunixin	30	30	AD	0	Not set	0
Meloxicam	30	30	5	0	5	0
Ketoprofen	30	30	25	0	50	0
Tolfenamic acid	30	30	25	0	50	0
Phenylbutazone	30	30	AD	0	Not set	0
Oxyphenbutazone	30	30	AD	0	Not set	0
Environmental Contaminants						
Organochlorines						
Aldrin & Dieldrin	30	30	75F	0	150F	0
BHC	30	30	50F	0	100F	0
Chlordane	30	30	30F	0	50F	0
Lindane	30	30	100F	0	200F	0
DDT	30	30	500F	0	1250F	0
Heptachlor	30	30	50F	0	150F	0
HCB	30	30	62.5F	0	500F	0
Endosulfan	30	30	AD	0	Not set	0

Compound or Analyte Residue	Number of samples		Level of Action[#] (µg/kg)	Number of detections at or above Level of Action	Australian Standard[*] (µg/kg)	Number of results above AU Standard
	Planned	Tested				
Environmental Contaminants						
Chemical Elements						
Arsenic	30	30	10	0	-	0
Cadmium	30	30	10	0	-	0
Lead	30	30	10	0	-	0
Mercury	30	30	10	0	-	0

F	These analytes are reported in the milk fat.
Not set	No standard has been set for the chemical in milk.
#	Refers to the level where follow up and/or investigatory action is undertaken. The level of action is set at 50% of the Australian or EU MRL whichever is more stringent or at the level of quantitation (LOQ) or at 'any detection' where no MRL has been specified.
*	Food Standards Australia New Zealand. *Food Standards Code. Schedules 19, 20 and 21*.
AD	Any detection.
-	No upper limit is applicable for the contaminant. Detections of the contaminant at low levels are allowable.
^	Residue identified below 50% of AU MRL, investigation undertaken for export purposes.
+	One sample missed the sample submission cut-off date, therefore excluded from this reporting. Result to be included in the next reporting.

Industry residue testing

In addition to residue monitoring performed in the Survey, many Australian dairy companies carry out their own on-site antimicrobial residue testing. This involves screening for antimicrobial residues from silos, bulk milk tankers, individual farm vat milk and in some cases, finished products.

Bulk milk tanker screening on arrival at the dairy factory is used by companies to determine the acceptability of milk for further processing. Testing of bulk milk silos and finished products is also carried out by some manufacturers as a further precautionary measure.

Testing of individual farm samples is undertaken by most dairy companies, either through routine supplier monitoring by the milk receival company and/or through proactive farmer requests for testing.

Many of these companies also have an on-site laboratory and participate in proficiency programs to verify the accuracy and consistency of their test results.

Nine dairy companies provided an annual summary of their residue test results for analyses performed during the 2023–24 year, which are collated in Tables 2 and 3. This information provides additional evidence that the Australian dairy industry's approach to agricultural and veterinary chemical usage is both responsible and effective in delivering safe food.

Antimicrobial residue testing

Table 2 provides an aggregate summary of antimicrobial residue test results performed by dairy companies on raw milk and finished product for the period 1 July 2023 – 30 June 2024.

A total of 539,305 routine antimicrobial screen tests were performed on raw milk from farms, bulk tankers and bulk silos and 99.96% of samples had no detectable residues. All dairy companies have documented food safety programs in place which describe how they manage antimicrobial residue detections and other chemical contaminants.

A total of 5,247 samples of finished products were also tested for antimicrobial residues, with no residue detections reported.

Table 2: Company residue testing results for antimicrobial residues (1 July 2023 – 30 June 2024)

Test Type	Number of Samples Analysed	Percentage of Negative Screening Detections (%)
Raw Milk – On-Farm	12,495	99.48
Raw Milk – Bulk Tanker	517,719	99.97
Raw Milk – Silo	9,091	100.00
Finished Product – (includes milk, cream, powders, butter, cheese and concentrates)	5,247	100.00

Other residue testing

Most large and some medium-sized companies conduct other residue testing in addition to antimicrobials. Samples taken from either raw milk or finished products were tested for various chemical residues including aflatoxins, pesticides and environmental contaminants. These results are presented in Table 3 as an aggregate summary.

Table 3: Company residue testing results for other residues performed on raw milk and finished products (1 July 2023 – 30 June 2024)

Test Type	Number of Samples Analysed	Percentage of Negative Detections (%)
Heavy metals	1533	100.00
Aflatoxin M1	1373	100.00
Organophosphates & synthetic pyrethroids	53	100.00
Organochlorines	31	100.00
Melamine	268	100.00
Cyanuric acid	29	100.00
Antimony	68	100.00

National Residue Survey

The National Residue Survey (NRS) is a monitoring program conducted by DAFF. The program aims to identify and monitor chemical residues in Australian agricultural commodities. The results for the NRS cattle meat and grains program demonstrate a high level of compliance with the ANZFSC[2], providing additional evidence of good agricultural and veterinary chemical use practices in the participating animal and agricultural production industries.

The *NRS 2022-23 Industry Brochure: National Residue Survey 2022-23 Annual Summary* [3] provides a summary of test results in agricultural products including cattle meat and grain crops. It is estimated that approximately 20% of Australia's meat production is derived from dairy cattle. The analytes tested in the NRS Survey include most of the analytes tested in milk by the AMRA Survey.

References

1. Australian Government Department of Agriculture, Fisheries and Forestry, *Export Control (Milk and Milk Products) Rules 2021,* (2021) <https://www.legislation.gov.au/Details/F2021L00304>

2. Food Standards Australia New Zealand, *Australia New Zealand Food Standards Code. Schedules 19, 20 and 21,* (2023) <https://www.foodstandards.gov.au/code/Pages/default.aspx>

3. Australian Government Department of Agriculture, Fisheries and Forestry, *NRS 2021-22 Industry Brochure: National Residue Survey 2022-23 Annual Summary*, (2023) <http://www.agriculture.gov.au/ag-farm-food/food/nrs/nrs-results-publications/industry-brochures/summary>

Appendices

Appendix 1: Extract from the Export Control (Milk and Milk Products) Rules 2021

5-26 Product standards – general

Contaminants, chemicals, additives etc.

(1) Prescribed milk and milk products and their ingredients must not contain any of the following that does not comply with a requirement of the Food Standards Code:
  (a) a level of metal or non-metal contaminant or a nature toxicant;
  (b) an amount of agricultural or veterinary chemical;
  (c) a food additive, processing aid, vitamin, mineral, added nutrient, or other matter or substance.

Note 1: For contaminants and natural toxicants, see Standard 1.4.1 and 1.4.4 of the Food Standards Code.

Note 2: For agricultural or veterinary chemicals, see Standard 1.4.2 of the Food Standards Code.

Note 3: For food additives, processing aids and vitamins, see Standards 1.3.1 to 1.3.3 of the Food Standards Code.

(2) Paragraph (1)(a) does not apply if:
  (a) importing country requirements provide for a maximum level of the contaminant or natural toxicant for the milk or milk products or their ingredients that is different from the Food Standards Code requirement; and
  (b) the approved arrangement for operations to prepare the milk or milk products provides for a system of controls to be implemented to ensure that the different requirement is compiled with; and
  (c) the system of controls referred to in paragraph (b) of this subsection is implemented in accordance with the approved arrangement.

(3) Paragraph (1)(b) does not apply if:
  (a) importing country requirements provide for an amount of agricultural or veterinary chemical for the milk or milk products or their ingredients that is different from the Food Standards Code requirement; and
  (b) the approved arrangement for operations to prepare the milk or milk products provides for a system of controls to be implemented to ensure that the different requirement is complied with; and
  (c) the system of controls referred to in paragraph (b) of this subsection is implemented in accordance with the approved arrangement.

(4) Paragraph (1)(c) does not apply if:
  (a) Importing country requirements provide for a food additive, processing aid, vitamin, mineral, added nutrient or other matter or substance for the milk or milk products or their ingredients that is different from the Food Standards Code requirement; and
  (b) The approved arrangement for operations to prepare the milk or milk products provides for a system of controls to be implemented to ensure that the different requirement is complied with; and
  (c) The system of controls referred to in paragraph (b) of this subsection is implemented in accordance with the approved arrangement.

Appendix 2: Number of samples tested in each Australian dairy state by test type for the 2023–24 AMRA Survey

Residue type	State*						
	VIC	NSW	QLD	TAS	SA	WA	Total
Amphenicols	13	6	0	7	0	3	**29**
Antimicrobials	192	42	5	32	17	12	**300**
Organophosphates & Synthetic Pyrethroids	147	23	4	29	20	7	**230**
Triclabendazole	24	4	0	2	0	0	**30**
Aflatoxin M1	20	2	1	3	2	2	**30**
Macrocyclic Lactones	148	34	5	22	13	8	**230**
Levamisole	9	4	2	4	1	0	**20**
Benzimidazoles	44	8	0	10	4	4	**70**
Non-steroidal Anti-inflammatory Drugs	18	4	2	3	1	2	**30**
Organochlorines	18	6	0	2	4	0	**30**
Chemical Elements	19	4	1	4	1	1	**30**

Key: * Australian States: VIC – Victoria; NSW – New South Wales; QLD – Queensland; TAS – Tasmania; SA – South Australia; WA – Western Australia.

Appendix 3: Contracted laboratories and residue tests performed

The 2023–24 AMRA Survey milk samples were analysed by two nationally accredited laboratories as listed below:

Lab	Residue Type	Test Method
National Measurement Institute 1/153 Bertie St Port Melbourne Vic 3207 Australia	Antimicrobials Screen	Microbial Inhibition Test (MIT) for beta-lactams, tetracyclines, macrolides and aminoglycosides. Thin Layer Chromatography (TLC) for sulphonamides
National Measurement Institute 1/153 Bertie St Port Melbourne Vic 3207 Australia	Antimicrobials Confirmation, Benzimidazoles, Levamisole, Macrocyclic Lactones, Triclabendazole, Aflatoxin M1 and Non-steroidal Anti-inflammatory Drugs	Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS)
BVAQ 5/352 Macaulay Road Kensington VIC 3031 Australia	Organochlorines, Organophosphates, Synthetic Pyrethroids	Gas Chromatography Tandem Mass Spectrometry (GC-MS/MS), Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS)
BVAQ 5/352 Macaulay Road Kensington VIC 3031 Australia	Amphenicols	Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS)

Contracted laboratories are required to be accredited by NATA to ISO/IEC Standard 17025 for the methods used in the AMRA Survey. Laboratories are also required to participate in a laboratory proficiency evaluation program coordinated by the NRS.