Microbiological Safety and Suitability of Raw Meat Petfood

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Scientific Interpretative Summary

This Scientific Interpretive Summary (SIS) is prepared by New Zealand Food Safety (NZFS) risk assessors to provide context to the following report for NZFS risk managers and external readers.

NZFSSRC406796/FW23013: Discussion Document: Microbiological Safety and Suitability of Raw Meat Petfood.

Raw meat petfood is an increasingly popular alternative to processed meat diets due to the perceived health benefits for cats and dogs. However, raw meat may be contaminated with microorganisms and pose a risk to both animal and human health. In addition, petfood has been shown to be a vehicle of transmission of antibiotic resistance as well as of human and animal disease. Contact with pets is not uncommon in human salmonellosis and campylobacteriosis cases, although direct links are often unproven. The research focus on petfood internationally has been on *Salmonella* but other zoonotic pathogens may be present in raw meat petfood.

There are limited prevalence data for the microbial hazards present in raw meat petfood products available in New Zealand. There is also minimal information available as to how these pathogens behave in these products as they move through raw meat petfood manufacturing, retail, and storage. This discussion document reviews information from New Zealand and internationally on microbial contamination of raw meat petfood, focussing on nontyphoidal *Salmonella enterica*, *Campylobacter* spp., Shiga toxin-producing *Escherichia coli* (STEC), *Listeria monocytogenes*, *Yersinia enterocolitica*, and *Toxoplasma gondii*. It also summarises information on how and which animals are sourced for raw meat petfood and how they are processed.

While there are no microbiological regulatory limits specified for raw meat petfood in New Zealand, petfood (as an agricultural compound) must be ‘fit for purpose’. This includes requirements that petfood will not spread organisms to a level or in a manner that could be harmful to humans, be toxic, or transmit disease to the animal when used as intended. Raw meat petfood products were deemed likely to have fewer critical control steps than meat for human consumption, and thus present a greater risk of exposure to pet owners handling such meat.

Since the completion of this report, MPI have updated the Petfood Processing Operational Code. The update consolidates three animal products regulations and 29 notices to make it easier for operators to comply with petfood processing requirements. NZFS will consider a microbiological survey of raw meat petfood, based on the information compiled for this report, to provide data on the microbiological quality of products in New Zealand. Results will help inform whether further action is required to manage any identified risks.

Microbiological Safety and Suitability of Raw Meat Petfood

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ABBREVIATIONS

AAFCO	Association of American Feed Control Officials
ACVM	Agricultural Compounds and Veterinary Medicines
AMR	Antimicrobial resistance
APA	Animal Products Act
AS	Australian Standard
AVA	Australian Veterinary Association
CFIA	Canadian Food Inspection Agency
cfu	colony forming units
CI	Confidence Interval
COVID-19	Coronavirus disease 2019
DALYs	Disability adjusted life years
EC	European Commission
EFSA	European Food Safety Authority
ERL	Enteric Reference Laboratory (at ESR)
ESBL	Extended spectrum beta-lactamases
ESCR	Extended spectrum cephalosporin-resistant
ESR	Institute of Environmental Science and Research Limited
EU	European Union
FD&CA	Federal Food Drug and Cosmetic Act
FSANZ	Food Standards Australia New Zealand
FSIS	Food Safety and Inspection Service (of the USDA)
FSMA	Food Safety Modernisation Act (of the US FDA)
HACCP	Hazard Analysis and Critical Control Point
HPP	High pressure processing
MLST	Multilocus Sequence Type
MP	Minimally processed
mOR	Matched odds ratio
MPI	Ministry for Primary Industries
NMD	National Microbiological Database
NZ	New Zealand

NZPFMA	New Zealand Petfood Manufacturing Association
OMAR	Overseas Market Access Requirements
OR	Odds ratio
PCR	polymerase chain reaction
PetFAST	Petfood Adverse Event System of Tracking
PFIAA	Petfood Industry Association of Australia
PFGE	pulsed-field gel electrophoresis
PIMC	Primary Industries Ministerial Council (of Australia)
PT	phage type
RASFF	Rapid Alert System for Food and Feed (of the EU)
RMP	Risk Management Programme
SD	Standard deviation
SE	*Salmonella* Enteritidis
ST	sequence type
STEC	Shiga toxin-producing *Escherichia coli*
TVC	total viable counts
UK	United Kingdom
US	United States of America
US FDA	United States Food and Drug Administration
USDA	United States Department of Agriculture
UTI	urinary tract infection
Vet-LIRN	Veterinary Laboratory Investigation and Response Network
WGS	whole genome sequencing
WOAH	World Organisation for Animal Health, formerly the Office International des Epizooties (OIE)

SUMMARY

The purpose of this discussion document is to collate and review information from New Zealand and overseas regarding microbial pathogens in commercially available raw meat petfood.

This report has been written in a similar manner to a Risk Profile, which normally considers a single food/hazard combination. Although the remit of this document is much broader, for consistency the general structure of a Risk Profile has been adopted.

The discussion document addresses microbial hazards, with a particular focus on the following pathogens:

- *Salmonella enterica* (non-typhoidal)
- *Campylobacter* spp.
- Shiga toxin-producing *Escherichia coli* (STEC)
- *Listeria monocytogenes*
- *Yersinia enterocolitica*
- *Toxoplasma gondii*

A raw meat petfood product is defined as the following: “where animal material (meat, offal, bone) either singly or in combination with other ingredients has not undergone a processing step or treatment beyond boning, slicing, dicing, mincing, mixing, forming, chilling or freezing”. Market data for the New Zealand raw meat petfood sector is limited but the general petfood market continues to show growth over time. Feeding raw meat to pets has also become markedly more popular worldwide in recent years, as pet owners seek to find ‘natural’ and health beneficial diets for their pets.

In New Zealand, most supermarkets sell raw meat petfood products that appear as chilled, fresh meat (not frozen) in pottles with a preservative or frozen (without a preservative). Many products available from petfood stores, speciality stores or online suppliers are frozen without preservatives and are predominantly in cubed or medallion form. A wide variety of meat species are used in raw meat petfood, including kangaroo (imported from Australia) and wild hunted animals (for example, deer, possum, rabbit/hare, and wallaby), including offal and other animal by-products from processors that process meat intended for human consumption.

The presence of microbial pathogens in these raw meat products pose a risk for both human and animal health. However, there are limited prevalence data for the microbial hazards in these products available in New Zealand. *Campylobacter* has been detected in a small survey of raw petfood in Palmerston North (2010) and all microbial hazards in scope have been detected in various international studies of raw meat petfood. There is also minimal information available as to how these pathogens behave in these products through raw meat petfood manufacturing, retail, and storage. Whether there are additional risks associated with New Zealand pet owners’ post-purchase habits and behaviours for handling and storing these products is also unclear.

In New Zealand, there have been no reported human illness outbreaks attributed to raw meat petfood. Notified human cases for some microbial pathogens can be sent a questionnaire regarding risk exposures, but the number of responses returned tend to be low and there are no specific questions about handling raw meat petfood. Internationally, there have been four reported outbreaks attributed to raw meat petfood in North America and the United Kingdom; two involving STEC O157:H7 and two *Salmonella* (including multi-drug resistant strains). Public health surveillance processes, including whole genome sequencing and identifying clusters of human cases along with follow-up interviews, have aided in identifying the source of two of these outbreaks. It is likely that most raw meat petfood feeding-associated human illness cases will be sporadic, and thus not investigated further for a cause. This indicates a potential area of under-recognition and under-reporting in New Zealand.

As there are multiple routes of possible transmission to humans of microbial pathogens associated with raw meat petfood, it is often not possible to unequivocally identify raw meat petfood as the source of human infection. International data show an association of feeding raw meat-based diets and microbial pathogens shed by pet animals. Symptomatic or asymptomatic shedding of pathogens presents a source of environmental contamination that can potentially lead to human and animal illness. The risk of infection through indirect routes of transmission, including contact with an animal shedding a pathogen or contact with a contaminated surface, is unclear but internationally, outbreaks have been reported to be linked to companion animals asymptomatically shedding pathogens.

There are no specific microbiological limits for commercial raw meat petfood in New Zealand, but the Petfood Processing Operational Code provides guidance to petfood processors to comply with the legislative requirements. The New Zealand Pet Food Manufacturing Association also provides guidelines for microbiological testing for these raw meat petfood for primary and secondary processors. Internationally, the European Union and the United States of America have microbiological limits for raw meat petfood products that focus on the presence/absence of *Salmonella* and/or *L. monocytogenes.*

International studies have shown that there is a need to raise awareness of the risks involved for both pet owners associated with raw meat petfood feeding and to provide guidance on use of hygiene practises to help limit potential cross contamination within a household. As pet owners look towards social media for information, the need for credible and trust-worthy evidence-based messages and recommendations regarding raw meat diets for pets is required. Veterinarians and petfood associations may also provide credible advice to pet owners on suitable products if a raw meat petfood diet is preferred.

Due to insufficient NZ data, it is not currently possible to estimate the human illness risk associated with exposure to microbial pathogens in commercial raw meat petfood. The large number of products on the market and their widespread availability suggests that a significant number of people are buying and feeding their pets raw meat petfood in New Zealand. These products are likely to have fewer critical control steps than meat for human consumption, and thus present a greater risk of exposure to pet owners handing such meat. Better information on the microbiological quality of the products on the market would greatly assist in assessment of risk. Recommendations for a potential survey of microbial hazards in commercial raw meat petfood products and the identification of the major data gaps areas are included in this document.

1 INTRODUCTION

Risk Profiles are a preliminary risk management activity, and part of the Risk Management Framework[1] approach taken by New Zealand Food Safety (NZFS), part of the Ministry for Primary Industries (MPI). The Framework consists of a four-step process:

- Preliminary risk management activities (including Risk Profiles);
- Identification and selection of risk management options;
- Implementation of control measures; and
- Monitoring and review.

This discussion document has been prepared in a similar manner to a Risk Profile, which normally considers a single food/hazard combination and provides information so that a risk manager can make decisions and if necessary, take further action. Although the remit of this discussion document is much broader, for consistency, the general structure of a Risk Profile has been adopted.

Table 1 provides a summary (or scope) of the types of commercially produced raw meat petfood and food safety microbiological hazards considered in this discussion document. The purpose of this discussion document is to collate and review information from New Zealand and internationally regarding key microbial pathogens in commercial raw meat petfood. The review of data will help identify data gaps in the current knowledge and make recommendations for possible surveys to help address data gaps.

The scope of this discussion document includes the risk to human health from direct contact and handling of raw meat petfood, and the risk from animal infections (shedding) resulting from consumption.

Background information concerning the characteristics of the microbiological hazards listed within scope is available in Appendix A, Table 18, and within datasheets and various Risk Profiles that are available on the MPI website (Appendix A, Table 19).[2,3] The information has therefore not been repeated here.

Appendix B also outlines the data sources used in this discussion document. Briefly, literature searches were conducted using keywords based on the food, and where information on additional bacterial pathogens was deemed relevant, it was included. The list of microbial hazards within scope is consistent with published reviews on the microbiological safety of raw meat petfood (Freeman et al. 2013, Lambertini et al. 2016, Davies et al. 2019).

[1] https://www.mpi.govt.nz/dmsdocument/22000/send (Accessed 5th April 2023)
[2] https://www.mpi.govt.nz/science/food-safety-and-suitability-research/food-risk-assessment/foodborne-hazard-data-sheets/ (Accessed 22 March 2023)
[3] https://www.mpi.govt.nz/science/food-safety-and-suitability-research/food-risk-assessment/food-risk-profiles/ (Accessed 22 March 2023)

Table 1: Scope of the discussion document

Scope	Included in scope	Excluded from scope
General	Raw meat petfood limited to that intended for cats and dogs, and that is commercially produced.	• Canned petfood – retorted or aseptically processed (low acid), packed in cans or pouches, shelf stable at ambient conditions and typically has a moisture content of 60-75% or water activity (a_w 0.85) (Ministry for Primary Industries 2018b). • Heat-treated refrigerated (wet) petfood – pasteurised, stored chilled or frozen and typically has moisture content of 60-75% or a_w 0.85). E.g., chilled dog rolls (Ministry for Primary Industries 2018b) • Semi-moist petfood and treats – heat treated, additional hurdle(s) is usually applied (e.g. a_w control, pH control, use of preservative). May be shelf stable at ambient conditions if mould growth is inhibited (e.g. vacuum packaging and or use of an anti-fungal agent). Typically has a moisture content of 25-35% or a_w 0.60-0.8. E.g. shelf-stable dog rolls, shelf stable semi-moist meat and vegetable chunks and soft jerky (Ministry for Primary Industries 2018b) • Petfood that has undergone high pressure processing/pasteurisation. • Dry petfood and treats – extruded, dried and baked. Shelf-stable at ambient conditions and typically has a moisture content of <10% or a_w 0.25-0.50. E.g., kibble and dog biscuits. • Dried pet chews and treats – heat treated and then dried (e.g., air dried), shelf stable at ambient conditions, typically has a moisture content of <10% or a_w 0.25-0.50. E.g. hard jerky, dried bones, ears, hooves, liver and pet chews produced from processed hides (Ministry for Primary Industries 2018b) • Raw meat that is intended for cooking and human consumption. • Home-prepared raw meat diets intended for animal consumption. • Raw meat that is preyed or hunted by the animal and consumed. • Any other animal feed intended for non-companion animals.
Raw petfood products	Domestically produced and imported petfood products that are commercially available in New Zealand, including various forms of the following product types: • Fresh and frozen raw petfood. • Obtained domestically (e.g., hunted or from farms) and sold commercially via markets or butcher shops. • Freeze dried raw petfood that is not heat treated prior to freeze drying. • Includes imported meat ingredients. • All animal meat types, excluding seafood.	• Raw meat that is sourced domestically (i.e., through hunted or from farms) provided to dogs/cats. Including minimally processed home-prepared diets. • Exclude finfish and shellfish commercially or domestically available. • Other supplement/treats/boosters with nutraceutical ingredients such as manuka honey, green mussel extracts and flax seed oils. • Other treats such as dog butters, cookies and bliss balls. • Pet milk. • Petfood products that are predominantly made from grains and/or other horticulture products (e.g., vegetables). • Bones and meat available at butchers intended for human consumption.

Scope	Included in scope	Excluded from scope
Hazards	• Pathogenic bacteria focusing on zoonotic pathogens including: • *Salmonella enterica* (non-typhoidal) • *Campylobacter* • Shiga toxin-producing *Escherichia coli* (STEC) • *Listeria monocytogenes* • Other microbial hazards which may include: • *Toxoplasma gondii* • Antimicrobial resistance	• Fungi and their toxins. • Other chemical contaminants that do not present a significant risk for human health if present within the product and most common exposure pathways (e.g., poisons from wild animal harvests, veterinary drugs).
Domestic/companion animals.	Companion animals that are domestic and that humans would feed commercially manufactured raw meat petfood. Focus on cats and dogs, including farm or working dogs.	• Reptiles that may be fed commercial raw meat products.

2 HAZARD AND FOOD

Key findings

- A raw meat petfood product is defined as: “where animal material (meat, offal, bone) either singly or in combination with other ingredients has not undergone a processing step or treatment beyond boning, slicing, dicing, mincing, mixing, forming, chilling or freezing”. Market data for the New Zealand raw meat petfood sector is limited, but generally the petfood market continues to show growth over time. Feeding raw meat to pets has also become more popular worldwide in recent years as pet owners seek to find ‘natural’ and health beneficial diets for their pets.
- The raw meat petfood products available in New Zealand are produced domestically with meat obtained from domestic farm species and wild hunted animals including deer, wallaby, rabbits/hares and possums. Kangaroo and lamb meat are also imported into New Zealand for petfood from Australia. The portion of those imported meats that are incorporated into raw meat petfood is unclear.
- Raw meat petfood is manufactured within a primary and secondary processing chain. There are primary processors that specialise in processing animals (often injured, not transportable or suitable for human food chain) for petfood, while some primary processors of animals for human consumption may also divert meat or by-products into the petfood chain if they are not fit for human consumption. Secondary “further” (petfood) processors process meat from primary processors, repackage and distribute for sale.
- The most commercially accessible raw meat petfood in supermarkets are chilled, fresh meat with a preservative or frozen without a preservative. There is more variety of meat mixes (including wild hunted animals) that are commercially available in pet shops, specialty stores and through smaller suppliers online. Offal from various animal species and beef meat are the most common ingredients included in products.
- Prevalence data for the microbial hazards in commercially raw meat petfood in New Zealand are limited but *Campylobacter* has been detected in a small survey of raw petfood. Data, including from the National Microbiological Database (NMD) programme from meat processed within the human consumption chain signals that some of these pathogens are present following primary processing, but that chain may have critical control steps that do not exist in the primary processing of raw petfood. Secondary processing steps may influence prevalence, growth, and survival of pathogens over time.
- The use of preservatives or freezing of raw meat petfood may inhibit growth and survival of microbial hazards but may not eliminate them over time. There is limited information as to how these pathogens behave in these products throughout manufacture, storage and shelf-life. It is therefore difficult to assess the downstream risks on exposure for pet owners in combination with potential high-risk handling practises by the owner.
- As there are multiple routes of potential transmission of microbial pathogens associated with raw meat petfood, it is often not possible to unequivocally identify raw meat petfood as the source of a human infection. The risk of infection through indirect routes of transmission including contact with an animal shedding a pathogen or contact with a contaminated surface is unclear.

2.1 RAW MEAT PETFOOD

A raw meat petfood product is defined as the following: “where animal material (meat, offal, bone) either singly or in combination with other ingredients has not undergone a processing step or treatment beyond boning, slicing, dicing, mincing, mixed, forming, chilling or freezing” (Ministry for Primary Industries 2018b). The focus of this discussion document is **commercially produced raw meat petfood.** However, related terms such as “raw meat-based diets (RMBD)”, “Biologically appropriate raw food” or “Bones and raw food (BARF)”, “prey diet”, “minimally processed” or “unconventional” diets were frequently encountered in the literature in reference to raw meat petfood. These terms often referred to pet diets that include uncooked ingredients from either livestock or wild animals that may be home prepared or commercially-manufactured, either used as a complete diets or to supplement a pet’s meal (Freeman et al. 2013, Davies et al. 2019, Cammack et al. 2021, Wales and Davies 2021).

For this discussion document, meat from farmed red meat animals, poultry and wild hunted animals including game estate animals were included (Ministry for Primary Industries 2022a). All seafood products were excluded.

Feeding products containing raw meat to dogs and cats has become markedly more popular in recent years among pet owners in many developed countries (Dodd et al. 2020). Historically, grain-based dry base foods have dominated the petfood market, but there is a clear shift to premium and unconventional foods, including raw meat petfood, underway in the market (Dodd et al. 2020). There are several factors that may be contributing to this surge in interest of raw meat petfood, including an increasing trend of pet owners treating their pets as part of the family, and pet humanisation, demanding better quality and spending more on their companion animals. At the same time, growing animal health issues, such as obesity, intestinal and joint issues, are driving pet owners to seek healthier and more natural products, even if the reputed health benefits are mainly anecdotal (Morelli et al. 2019, Wales and Davies 2021). There is also an increasing consumer awareness of natural and organic petfood formulated with high quality and functional ingredients (Coriolis 2021).

2.2 NEW ZEALAND PET FOOD INDUSTRY

The Ministry of Business, Innovation and Employment commissioned Coriolis Research to investigate New Zealand’s top export opportunities. Their report found the petfood industry to be one of the top five opportunities (Coriolis 2021). Growing demand has driven increasing global cross-border trade in petfood and ingredients. New Zealand’s comparative advantage in meat and protein is driving growth in the petfood industry, in particular due to the availability and reliable supply of meat-based ingredients (including lamb and beef) and innovation around retail-ready products (Coriolis 2021).

New Zealand has a strong position in the global meat industry that is translating into growing petfood exports. As an example, the New Zealand petfood industry has been growing, from 36 firms in 1955 to 139 in 2020 (Coriolis 2021). The supply of key meat-based petfood ingredients have plateaued since 2008. Significant investment in new capacity is being made by export focused retail-ready manufacturers and New Zealand petfood firms are expanding their range and targeting a more premium end of the market (Coriolis 2021). For example, petfood manufacturers are identifying “on trend” areas which include the use of freeze-drying and marketing as “raw” for petfood and using unique, signature New Zealand ingredients such as brushtail possum, deer or lamb and pushing areas of interest such as the ‘prey diet’ (Coriolis 2021).

New Zealand has also been recognised as an attractive market for United States of America (US) petfood exports. The US is the number one supplier of petfood products to New Zealand with US$120 million imported in 2019. The trends observed for New Zealand follow that of other Western markets and include organic, natural including 'raw food/dehydrated', with fast re-hydration times and more convenient packaging (United States Department of Agriculture Food Safety and Inspection Service (USDA-FSIS) 2020).

Domestic market data for the New Zealand raw meat petfood sector is limited. Data provided by the New Zealand Petfood Manufacturers Association (NZPFMA) confirmed that in general, the cat and dog food market are each continuing to grow with approximately +12% increase by value in 2023 compared with 2022 (Richard Brake, NZPFMA. Personal communication.19 January 2023). These data include all petfood products available within the supermarkets which represents approximately 75% of the retail ready petfood.

Market data from retailers that are not supermarkets was not able to be provided by NZPFMA, as many retailers are not NZPFMA members (Richard Brake, NZPFMA. Personal communication.19 January 2023).

As a comparison, in the US, sales of raw petfood increased 70% between 2015 - 2018, with year-on-year growth over the last 10 years.[4] In Canada, a similar trend is also reported where the number of stores selling raw petfood and the overall sales of raw petfood have more than doubled from 2012 - 2016.[5] Although the raw meat sectors make up a small percentage of the overall petfood market, the increasing consumer interest in these types of products is likely to stimulate growth of these products on the market.

2.3 NEW ZEALAND RAW PETFOOD MANUFACTURING CHAIN

Figure 1 provides an outline of the New Zealand petfood production and distribution chain, which fundamentally involves primary and secondary processors. Primary processing involves either:

a) the supply and presentation of animals for slaughter,

b) slaughter and dressing of farmed animals, and

c) harvesting, refrigeration and dressing of wild hunted animals.

Secondary processing includes all processing that occurs after the carcass has passed post-mortem inspection and includes:

a) cutting and boning of carcasses and cuts,

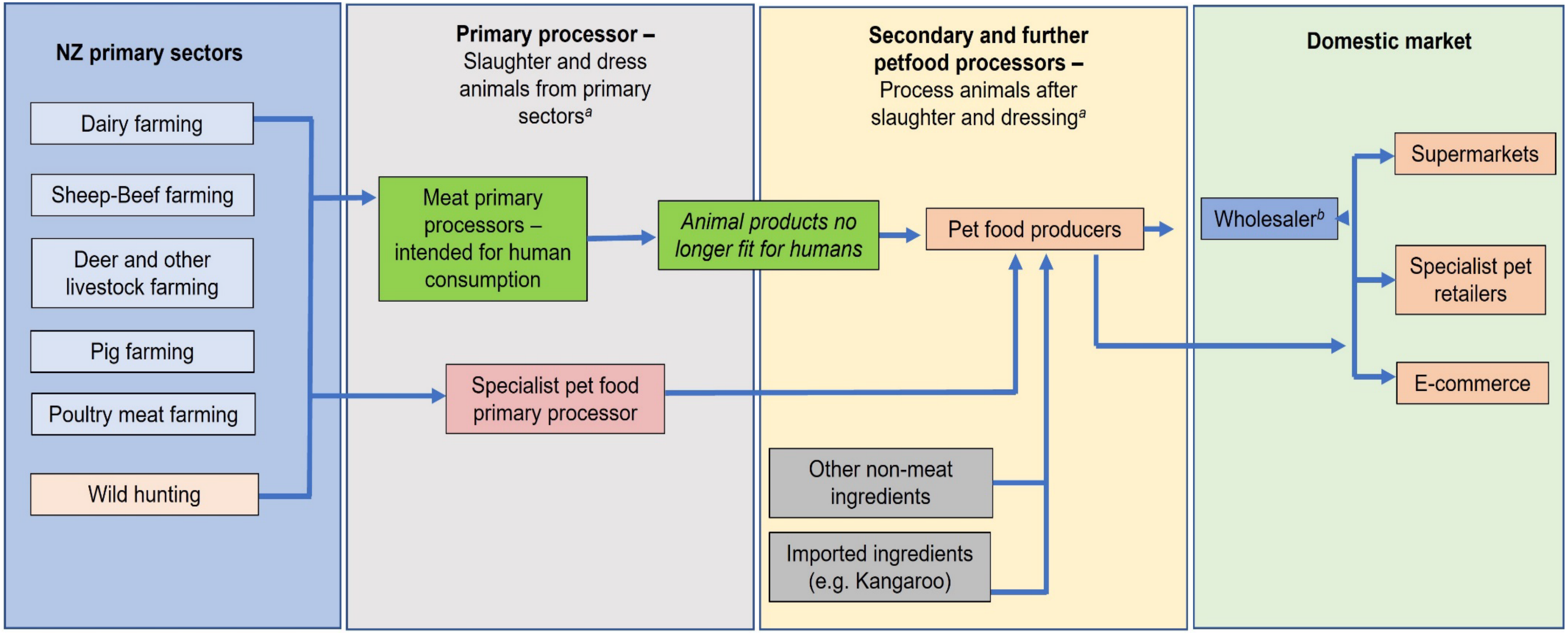
b) further processing and manufacturing of petfood,

c) packing,

d) refrigeration; and

e) storage.

[4] https://www.petfoodprocessing.net/articles/14294-state-of-the-us-pet-food-and-treat-industry-2020 (Accessed 7 June 2023)
[5] https://petconnection.ca/industry-rules-and-raw-pet-food-safety/ (Accessed 7 June 2023)



Adapted from Coriolis (2021). Other ingredients from sectors such as horticulture and seafood not included and international market distribution as it is out of scope.
[a] Some processors may be both primary and secondary processors.
[b]Third party manufacturing and distribution may occur with some products and there may also be more than one layer of wholesale occurring. Some manufacturers directly provide to the market predominately via online sales (e-commerce).

Figure 1: Outline of the raw meat petfood production and distribution chain in New Zealand

Some New Zealand processors are both primary and secondary processors. There are primary processors that manufacture food intended for humans but also food for animals using foods no longer fit for human consumption. There are also primary processors that specialise as petfood manufacturers only.

A New Zealand primary producer of meat intended for human consumption indicated that by-products of ovine and bovine sources are supplied fresh or chilled for short term storage for daily collection for another company that then sorts and freezes (blast or plate freezer) them into 'naked' blocks. These blocks are then sold on to various markets which can include petfood. The amount of product directed to raw meat petfood from this producer is not known (ANZCO. Personal communication. 30 March 2023).

Secondary "further" (petfood) processors process petfood from animals (i.e., raw meat, animal materials or animal products) after post-mortem examination from regulated primary sources. Exceptions apply to rendered[6] product and product acquired in a ready-for-sale state and has been subject to primary processing in accordance with a registered risk management programme (RMP) by an earlier processor.

Many of the secondary "further" (petfood) processors often supply product to pet shops and are closely associated with primary processors (Richard Brake, NZFPMA. Personal communication, 19 January 2023).

The New Zealand regulatory framework for raw meat petfood manufacturing is outlined in Section 270565760.6695.1, which outlines the minimal risk animal materials suitable for raw petfood.

Although a number of animal meat species can be directed to primary and secondary processing chains for petfood, animals from the dairy industry are predominantly used in raw meat petfood products that are commercially available. Those primary processors that process animals only for petfood receive animals that are injured, not transportable or suitable for the human food chain. For poultry, there is one predominant processor in New Zealand that processes end-of-lay birds for petfood (Richard Brake, NZFPMA. Personal communication, 19 January 2023).

Wild-hunted animals can also be harvested for use as petfood only and can include *inter alia*, rabbits and hares, wallabies, possums, wild birds, pigs, goats, and deer. Many of these animal species are pests in New Zealand and are subject to culling programmes designed to manage populations.

2.4 COMMERCIAL RAW MEAT PETFOOD PRODUCTS AVAILABLE IN NEW ZEALAND

2.4.1 Product range

An online search was performed in March 2023 to obtain a snapshot of the types of raw meat petfood that are commercially available in New Zealand. Details of the process used for the search are outlined in Appendix B2.

[6] Rendering is defined as the means of breaking down of animal tissues into constituent fat and protein elements, whether by the application of heat and pressure or otherwise (New Zealand Food Safety Authority 2009).

A total of 31 companies manufacturing a total of 564 commercially available raw meat petfood products were identified. Of those companies, 20 were listed as registered secondary "further" petfood processors.[7] The remaining companies did not appear on the MPI secondary "further" petfood processor list but may be registered as primary or secondary processors with MPI.

The following observations were noted:

- There are approximately five brands of raw meat petfood products in the New Zealand supermarkets that were chilled (they appear as fresh meat, but it is difficult to ascertain whether the meat was previously frozen) or frozen. Three of these brands are owned by one company. The chilled products typically appeared as chunks of muscle meat with or without offal (for example, heart, liver, and kidney) within a pottle and contain one or more preservative. Only one brand specified the preservatives used as sodium metabisulfite and potassium sorbate. One brand was in a pouch (vacuum-sealed) with a preservative (not specified). The frozen products appeared as medallions or small pieces of meat without a preservative.
- There was more variety of raw meat products available through pet shops, speciality stores and online petfood suppliers, with the most predominant form being frozen (no preservatives). Some suppliers offer a subscription and/or delivery service which includes bulk products (1 – 20 kg packages). Many suppliers indicate that the products can be fed to dogs, cats, kittens and/or puppies. Some suppliers had products specifically for working dogs or for puppies/kittens (finely minced).
- A wide variety of animal species and components are listed as ingredients within the raw meat petfood products (Table 2 and Table 3). Most products included a blend of a variety of animal species muscle meat and offal in various combinations. These products were most often cubed or in medallions and frozen. Some animal species such as possum, rabbit/hare were incorporated and minced as whole (with bones and organs). There were specific products such as green unbleached tripe from ruminant animals that were sold as frozen cubes. This type of green offal can be any part of the alimentary tract that has not been cleaned of the inherent contamination (Ministry for Primary Industries 2022b).
- Many products indicated New Zealand-sourced meats, including wild game animals (for example, deer, possum, wallaby, rabbit, hares, duck, and turkey). Offal from various animal species was the most frequently observed ingredient (Table 3). Beef meat was the most frequently observed meat, followed by chicken (poultry) and venison.
- There were two companies identified that produced raw meat petfood with kangaroo meat. One company supplies to the supermarkets (as non-frozen product). Both companies' websites indicated that kangaroo meat was sourced from Australia.
- There were also several products from the same suppliers of blended raw meat petfood products that were portions or parts of the animal with bone. For example, chicken feet, carcass frames, necks, briskets, spine and tails.

[7] https://www.foodsafety.govt.nz/registers-lists/further-petfood-processors.htm?setup_file=further-petfood-processors.setup.cgi&rows_to_return=20000&submit_search=Search (Accessed 22 March 2023)

Table 2: Animal species and animal component types observed within commercial raw petfood products in New Zealand

Bovine (beef/veal)	Ovine (lamb/mutton)	Avian	Deer	Goat	Possum
Muscle meat	Muscle meat	**Chicken**	Muscle meat	Muscle meat	Muscle meat
Heart	Mutton meat	Muscle meat	Bones (neck, scapula)	Bone with meat	Heart
Liver	Heart	Necks	Heart	Offal[1]	Liver
Kidney	Lamb liver	Feet	Liver	Spleen	Kidney
Tripe (green, unbleached)	Tripe (green, unbleached)	Carcass frames	Kidney	Tongue	Whole (with organs[1])
Tail	Lung	Meat with bones	Ribs	Heart	Tails
Tongue	Brisket (with bone)	Heart	Brisket (with bone)	Lung	Bone with meat
Cheek	Trachea	Gizzards	Tripe (green, unbleached)	Kidney	Lung
Bone with meat		**Turkey**	Spleen		
Brisket (with bone)		Muscle meat	Tongue		
Neck		Wings	Lung		
Pluck		Drums			
Throat		**Duck**			
Offal/organs[1]		Muscle meat			
		Feet			
		Carcass frame			
		Wings			
		Quail – whole			
Rabbit/Hare	**Wallaby**	**Kangaroo**	**Alpaca**	**Pig**	**Horse**
Muscle meat	Muscle meat	Muscle meat	Muscle meat	Heart	Muscle meat
Whole (with organs[1])	Wallaby tails		Offal[1]	Trim	
Portions with/ without hair				Tail	

Notes: [1]Some products indicated offal/organs without specifying which animal.

Table 3: Number of observations of different meat and components as ingredients within commercial raw meat petfood ingredients identified in New Zealand (n = 564 products)[1]

Component	Number of observations
Offal unspecific[2]	138
Beef	122
Chicken	75
Venison	65
Rabbit/Hare	52
Chicken other[3]	51
Lamb	42
Goat	40
Veal	39
Possum	32
Turkey/Quail	19
Wallaby	17
Horse	16
Lamb tripe	15
Venison other[3]	14
Beef heart	12
Duck	12
Sheep	12
Lamb liver	11
Pork	10
Lamb other[3]	10
Beef liver	9
Pork other[3]	9
Beef kidney	8
Kangaroo	5
Beef tripe	4
Lamb kidney	4
Sheep heart	2
Alpaca	2
Sheep liver	1

Notes:[1] Products without an ingredient list were not included in this table. Some were included if an ingredient was clear on the product title. Some products may also represent a mix of species depending on availability and all potential animal species were included in the table.
[2]'Offal unspecific' are products that indicate an offal (liver, kidney, trachea etc) but did not specify from which animal species.
[3]'Other' includes offal or other components such as bones, e.g., chicken frames, veal bones. 'Pork other' only had hearts and tails.

- Several suppliers indicated that products with poultry originated from processors of poultry for human-consumption.
- Less frequently observed animal species included pig, horse, alpaca, and kangaroo. Some of the wild animal species and veal products were noted to have seasonal availability.
- One company with multiple brands of chilled and frozen raw meat pet food available in the supermarkets did have handling guidelines for safe use, including washing of hands, surfaces and utensils after use and keeping the raw meat separate from other foods. Frozen products available in the supermarkets and/or major pet stores also had recommendations to keep the product frozen until use and thawing in the refrigerator or serving a portion in a bowl and defrosting for 30 mins prior to serving. Recommendations also included to refrigerate leftovers immediately or discard 30 mins after offering the feed to the pet. One brand of chilled raw meat pet food observed in supermarkets had no handling instructions for the purchaser.
- It was difficult to ascertain labelling or packing information for many products available for purchase online. Many were displayed in photographs online without packaging or within a sealed bag with a simple label including the brand and the statement "petfood only/not intended for human consumption". Minimal to no handling, thawing or use-by-once-thawed instructions or guidance was observed for most of these products online. Some suppliers' websites did provide some information regarding proper handling of raw meat petfood, including washing of hands and surfaces after handling. A variety of instructions were found for serving and thawing of frozen product. Some companies' websites recommend keeping the product frozen until use, with no clear instructions for defrosting. One company indicated defrosting in the microwave and another in a bowl of warm water prior to feeding. Others indicate that frozen portions can also be served directly to the dog. Two companies indicated that their product could last three-days in the fridge once defrosted. Another stated that once opened, the product can be consumed within five days.
- Some of the companies that supply product online were observed to have questionable statements regarding the food safety of raw meat petfood. A number of companies state the use of 'high quality ingredients', which can give the impression of a safe product to the purchaser. More concerning was many statements observed that provided misinformation as to the risk of raw meat petfood feeding to animals, often without supporting evidence-based studies.
- All seafood was excluded from Table 2 and 3, but some products also had mixtures of meat with fish, particularly salmon and other non-meat ingredients such as green lipped mussel and egg or other nutritional additions (e.g., micronutrients).

There were a number of companies selling frozen raw meat petfood online, which involved courier delivery of the products to consumers' homes. In many cases these companies specified only local delivery or within the North Island or South Island. It has been reported globally that online purchasing of petfood from the internet has become common in the last few years, especially during the COVID-19 pandemic (Morelli et al. 2019, Morelli et al.

2020).[8, 9] For two companies, their websites indicated that as long as the product arrived chilled then it was safe to refreeze.

There were also some commercial brands that had **freeze-dried** products with 'raw meat' stated on their packaging or branding (excluded from Table 2 or Table 3). Freeze-drying involves removing water from a product within a vacuum at very low temperatures. The process leaves the food nearly unchanged nutritionally compared with raw frozen product, but with a much lower water content/activity. Different formats of this type of product may be present in the market as frozen or shelf stable.

Many of the freeze-dried products available commercially may indicate raw meat from various animal species as ingredients, but also come in a number of formulations, with bones, vitamins and mineral mixes, vegetables and other non-meat ingredients to provide a 'complete and balanced' diet for pets. Freeze-dried petfood is a standout area for export growth for New Zealand (Coriolis 2021). Some larger New Zealand manufacturers of freeze-dried petfood state on their websites, the use of high-pressure processing (HPP) of ingredients prior to freeze drying but these manufacturers also export these products to countries such as the US where stringent microbiological regulations exist. HPP is a non-thermal process that utilises hydrostatic forces exerted on water molecules (or any incompressible fluid) in a system, such as a food, to inactivate pathogenic and food spoilage microorganisms (Kiprotich and Aldrich 2022).

HPP-treated petfood is out of the scope of this discussion document [a review document on HPP is available from MPI (Horn 2019)]. However, it was difficult to ascertain from packaging information of commercially available freeze-dried product and one non-frozen petfood product, whether HPP is used as a process step. Although there is limited published research investigating the use of freeze drying and HPP, individually or in combination, to inactivate enteric foodborne pathogens in commercial raw meat petfood, each process inactivates most types bacteria including *Salmonella* and *Listeria* (Considine et al. 2008, Serra-Castelló et al. 2022a, Serra-Castelló et al. 2022b, Serra-Castelló et al. 2023). As well as improving the food safety of the product, HPP of raw meat petfood offers several other benefits, including extended shelf-life (and therefore greater distribution for a company) and preserves heat-labile nutrients like vitamins, pigments, antioxidants and flavour/volatile compounds (Georget et al. 2015, Huang et al. 2017).

Dehydrated or air-dried raw petfood are heated to remove almost all of their water content. These products are out of scope for this discussion document due to the heat treatment they receive. Drying results in a reduction of microbial numbers but *Salmonella* and other pathogenic bacteria can survive in low moisture environments (Chitrakar et al. 2019). The review of commercial raw meat petfood in New Zealand documented many smaller suppliers of raw meat petfood that also listed petfood products that were dried, and some that did not have obvious packaging. Whether these products are within the same processing environments as raw meat petfood is unclear but may pose questions as to the risk of pathogens, particularly *Salmonella* cross contamination during production between these dried and raw-meat products within a single establishment. Factory colonisation by *Salmonella* in dry dog food production has been reported to pose a risk of contamination of these products even after heat treatment (Health Canada 2006, Behravesh et al. 2010).

[8] https://www.petfoodprocessing.net/articles/14294-state-of-the-us-pet-food-and-treat-industry-2020 (Accessed 3 March 2023)
[9] https://petconnection.ca/industry-rules-and-raw-pet-food-safety/ (Accessed 3 March 2023)

2.5 RAW MEAT PETFOOD OR RAW PET MEAT IMPORTED INTO NEW ZEALAND

Frozen meat, intended for petfood, derived from cattle, deer, goats, horses, sheep, kangaroo and rabbits from Australia can be imported for further processing in New Zealand under an import process covered by MPI.[10, 11]

The online search of commercial raw meat petfood outlined in Section 2.4.1 did not identify imports to New Zealand of any ready-for-sale commercial raw meat petfood. This observation was also supported by Richard Brake from NZPFMA (Personal communication, 19 January 2023), who indicated that the commercially produced raw meat petfood available in New Zealand is domestically manufactured.

Although some available product information did not include details of the source of all ingredients, many processors' websites or packaging information indicate that their products were domestically manufactured using meat from New Zealand domestic farmed or wild hunted animals, and many were from MPI approved processors.

Two supermarket-available brands of raw meat petfood (from the same primary company) and a smaller company of frozen raw petfood, included kangaroo meat in products. The websites of both companies stated that kangaroo used in these products were sourced from Australia. Otherwise, there was no other information on any other commercial product that indicated imported raw meat ingredients.

A search for import volume data for raw meat petfood between January 2020 and February 2023 was performed by MPI Biosecurity Data Services using the search terms 'kangaroo', 'rabbit' and 'animal food'. Appendix C, Table 21 outlines 44 consignments for kangaroo meat that were identified through the search, and all were labelled as from Australia. Caution must be taken when interpreting this data, as the import report forms submitted to MPI can have inconsistencies with spelling or insufficient detail provided. As a result, some relevant records may not have been captured in the searches performed, representing a possible underestimation of the volume data presented. Also, despite the report forms requesting consignment weights, the values observed in entries were inconsistent and may not accurately reflect the total weight of a consignment. Therefore 'units' will be used to describe the import volume in this document.

The amount of kangaroo meat imported into New Zealand according to all identified data (Appendix C, Table 21), ranged from a total per year of 223,381 units in 2020, 129,853 units in 2021 and 169,430 units in 2022. There were 30 consignments that were labelled with 'petfood' or listed within the product a sub-class of 'petfood', with the total amounts per year ranging from a total of 159,814 units in 2020, 122,045 units in 2021 and 125,335 units in 2022. The remaining consignments of kangaroo meat did not specify whether they were intended for human or animal consumption.

No consignments were identified to include rabbit meat. However, additional meat products labelled as 'petfood' were observed (Appendix C, Table 21) and these predominantly featured frozen lamb from Australia. A single consignment in 2022 was for pig hearts (from Australia).

[10] https://www.mpi.govt.nz/import/food-animals/pet-food/steps-to-importing/ (Accessed 28 February 2023)
[11] https://www.mpi.govt.nz/dmsdocument/1799/direct (Accessed 22 March 2023)

2.6 BEHAVIOUR OF PATHOGENS IN RAW MEAT PETFOOD

2.6.1 Commercial processing

The growth requirements for the microbial hazards within the scope are provided in more detail in Appendix A, Table 18.

There is limited information or data with respect to the prevalence or behaviour of the microbial hazards of interest in commercial processing of raw meat petfood in New Zealand and internationally.

Unlike heat-processed petfood, there is no late-stage critical control step for destroying microbial hazards. The quality and provenance of ingredients is therefore of high significance in respect to safety. The choice of ingredients and the process of manufacturing fresh raw meat petfood result in products that are highly perishable because they have a relatively high pH (5.5 - 6.5) and water activity of >0.98 (Kiprotich and Aldrich 2022). Commercial raw meat petfood does not undergo pasteurisation or other treatments to help control microbial growth. Proper time and temperature controls are essential to minimise potential pathogen growth in the product from manufacture, during transportation and storage to the point of consumption or use.

Fresh meat can support the growth of a wide variety of microorganisms (ICMSF 1998). However, *T. gondii*, does not multiply in meat (De Berardinis et al. 2017). *Salmonella*, STEC and *Campylobacter* are unable to grow at low temperatures below 5°C but they can survive at these temperatures. Generally, numbers of viable bacterial cells decrease with time during refrigerated storage and the rate of decline is dependent on factors such as pH, water activity and the presence of other inhibitory substances (Doyle 2002). Other bacteria, including *L. monocytogenes* and *Y. enterocolitica* and some spoilage bacteria, are psychrophiles and can grow slowly at refrigeration temperatures. Some pathogenic bacteria such as *Y. enterocolitica* and *L. monocytogenes* are not very good competitors and grow much more slowly in the presence of other bacteria present on meat (Doyle 2002).

The New Zealand Operational Code for Petfood Processing recommends that animal material should be continuously cooled until the required preservation temperature is reached. The generally accepted preservation temperature for chilled meat is +7°C or cooler and frozen meat at -12°C or cooler (Ministry for Primary Industries 2018b). Rapid chilling of animal carcasses after slaughter and during processing is important for retarding the growth of both pathogenic and spoilage bacteria.

Antimicrobial control steps implemented by New Zealand primary processors of meat for human consumption can include scalding and spraying/immersion in acidified sodium chlorine solutions (for poultry). When these treatments are properly controlled and applied then the majority of pathogens such as *Salmonella* and *Campylobacter* present on the surfaces of meat should be inactivated, but it is possible that these pathogens are also protected within niches on the carcass during treatments (Kingsbury 2023, Kingsbury et al. 2023). For ovine and bovine (including veal) processing, steps may also include pre-evisceration carcass washes, spray chilling or hot washes (for example, used for green offal). If these interventions are not included, then the prevalence and numbers of pathogens are likely to be much higher on these meat carcasses and components following primary processing in comparison with those intended for human consumption.

Secondary processing of raw petfood may occur at the same facility as primary processing, or carcasses may be transported to another location for secondary processing. As outlined in Section 2.3, primary processors supplying by-products from the human-consumption processing chain may hold these products fresh and chilled for daily collection by another company. As with meat for human consumption, secondary processing for petfood may include activities such as portioning, deboning, blending, mixing and packing.

A New Zealand study investigated how primary and secondary processing steps affected *Campylobacter* numbers on chicken carcasses and portions intended for human consumption (Kingsbury et al. 2023). Primary processing reduced *Campylobacter* numbers on carcasses by almost 6-$\log_{10}$ cfu/carcass with the biggest reductions mediated by the immersion (spin)-chill step, followed by the scald step. However, there were significant plant differences in the extent of *Campylobacter* reduction observed for some processing steps. *Campylobacter* numbers from final product from secondary processing were higher than numbers at the end of primary processing. As outlined in the Risk Profile update for *Salmonella* in poultry, there are no recent New Zealand data to show whether the prevalence or number of salmonellae changes through secondary processing (Kingsbury 2023). Studies from other countries have reported higher numbers of *Salmonella* on portions compared with carcasses (Kingsbury 2023). Secondary processes may also affect the prevalence or numbers of these pathogens in raw meat petfood products.

It is unknown whether primary or secondary processors of petfood undertake similar critical control steps and procedures to those processors producing meat intended for human consumption. These processes may affect prevalence and numbers of these pathogens through cross contamination, exposing these pathogens that had been protected in hospitable niches, or by reducing hospitable niches (Kingsbury 2023).

Indeed, some secondary processors and suppliers indicated that raw meat petfood contained poultry from processing chains intended for human consumption. Some of these are minced with bone in, with or without other meat, or are sold on as pieces. Whether additional processing steps undertaken in the secondary 'further' processing phase impacts on the potential growth and/or survival of *Salmonella* or *Campylobacter* and presents an increased risk of these pathogens in raw meat petfood, is currently unknown.

The vast majority of raw meat petfood product available commercially in New Zealand is frozen, without preservatives. Freezing can reduce numbers for many pathogens in raw meat, but the effects vary by pathogen and by the temperature and duration of freezing. For example, one study from New Zealand reported that the numbers of inoculated *Campylobacter* bacteria (10^3 or 10^6 cfu/g) on beef trimmings decreased initially by ~0.6 to 2.2 log cfu/g during the first 7 days of storage at -18ºC. Numbers of viable *Campylobacter* bacteria then remained constant over the remaining 112 days of the trial (Moorhead and Dykes 2002). Other studies have also observed a decrease in the viability of *Campylobacter* following freezing and refrigerated storage of poultry meat, chicken livers and skin (Solow et al. 2003, Georgsson et al. 2006, Oyarzabal et al. 2010, Sampers et al. 2010, Huang et al. 2012, Harrison et al. 2013). In addition, *Campylobacter* spp. can assume a viable but nonculturable state under stressful conditions such as those during refrigeration and freezing (Li et al. 2014).

In contrast, studies have shown that freezing (-20°C) had minimal effect on inoculated *Y. enterocolitica* in raw pork, *E. coli* O157 in beef trimmings and other STEC in frozen meat and *Salmonella* Typhimurium and *Listeria innocua* on chicken breast (Bhaduri 2005, Dykes 2006, Pradhan et al. 2012, Ro et al. 2015), so freezing is not considered to be an adequate control step for all pathogens.

Freezing renders *T. gondii* inactive (Kotula et al. 1991, Lundén and Uggla 1992).

As outlined in Section 2.3, by-products from processors of meat for human consumption may be sorted and frozen into 'naked' blocks which are then sold on to various markets, including petfood. It is unclear whether some secondary processors of raw meat petfood subsequently defrost these blocks, further process (mince and mix with multiple meats and by-products) and re-freeze the product prior to supply/distribution. The impact of these additional freezing steps on the microbial pathogens present in the final product is unknown.

2.6.2 Potential growth and cross contamination of microbial pathogens at retail and domestic handling

There is limited literature that describes the effects of storage of chilling or freezing on the survival of microbial pathogens in commercial raw meat petfood.

Salmonella, STEC, *L. monocytogenes* and *Campylobacter* can survive refrigeration temperatures and will grow under warmer, more favourable temperatures. Therefore, time-temperature control is important. The potential for microbial outgrowth and spoilage restricts the shelf life of raw, fresh meat. The rate of spoilage is influenced by factors such as temperature, the presence of oxygen, and the type of packaging (Stopforth 2017, Alessandroni et al. 2022). All these factors, including the presence of other microbes, also affect the behaviour of pathogens.

The raw meat petfood products available commercially in New Zealand that are not frozen were observed as either pieces of meat in pottles with a preservative or were vacuum sealed in packaging (for example, veal bones and one brand of non-frozen raw meat petfood). All but one brand of non-frozen raw petfood available in the supermarket did not specify the preservative used. The brand with preservatives, listed sodium metabisulfite and potassium sorbate.

Sulphites (including sodium metabisulfite) are food additives that are widely used as a preservative in some foods due to their antimicrobial, colour-stabilizing, anti-browning and antioxidant properties (EFSA Panel on Food Additives Nutrient Sources Added to Food 2016).[12] Thiamine (Vitamin B12) deficiency can occur when dogs and cats are fed on a diet containing sulphite preservatives (such as sodium metabisulfite), which can cause severe neurological symptoms and can be fatal.[13] The Australian Standard for Manufacturing and Marketing of Petfood (AS 5812-2017) contains clauses that include a mandatory requirement that any product containing sulphur dioxide, sulphite or potassium sulphites must contain sufficient thiamine according to Association of American Feed Control Officials (AAFCO) guidelines, for the entire shelf life of the product. This helps with preventing thiamine deficiency in relation to manufactured petfood.

Potassium sorbate is also a food additive that is used as a preservative and antioxidant in a wide range of commonly consumed foods, including semi-moist petfood (EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) 2012).

It is possible that organic acids such as acetic, citric and lactic acids which are generally recognised as safe, may be used as preservatives as they have been applied on animal and poultry meats as inexpensive antimicrobial interventions, but have been shown to have variable efficacy against foodborne pathogens (Mani-López et al. 2012, Kiprotich et al. 2021,

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[12] https://www.mpi.govt.nz/dmsdocument/21407-Sulphur-dioxide-sulphides-in-meat.pdf (Accessed 27 March 2023)

[13] https://kb.rspca.org.au/knowledge-base/are-preservatives-in-pet-food-products-a-concern/ (Accessed 27 March 2023)

Kiprotich and Aldrich 2022). A review of published studies which investigated the effects of organic acids at various doses on enteric foodborne pathogens in meat and poultry products, reported log reductions that ranged from 0.3 to 4.3 log cfu/g for *Salmonella* and *E. coli* O157:H7. Higher log reductions were observed in chunks or cuts of meat compared with ground meats. The log reductions of pathogens were also dependent on the type and concentration of acidulant used to treat the meat (Kiprotich and Aldrich 2022).The broad potential applicability of organic acids in food products to enhance safety and quality is complicated because high acid and low pH usually alters the sensory properties of meats and poultry (Kiprotich et al. 2021).

In New Zealand, raw meat petfood products are likely either transported fresh or frozen from suppliers to the supermarkets, petfood stores or couriered directly to consumers as frozen product. Provided that the temperature is maintained at 7°C or below (ideally 4°C or below), pathogen growth will be minimised depending on the pathogen. This is especially important for suppliers that sell product online and ship to their clients using couriers, where an insulated shipping container with adequate cool pack is essential to ensure the product remains frozen. Time control depends on the distance and type of courier service used. The courier may experience delays in transportation or handle the package in the same way as non-perishable packages, which may expose the package containing raw petfood to temperature abuse conditions, depending on the season and route of the delivery trucks (Hallman et al. 2013).

Available information on New Zealand consumer transportation, refrigeration, and handling of raw meat have focused on products intended for human consumption and purchased from retail outlets (Gilbert et al. 2007, McIntyre et al. 2007, Al-Sakkaf et al. 2021). Most consumers (94.4%) claimed that the time taken from food selection to the product reaching their home was one hour or less, which is not likely to cause any significant growth in pathogen numbers, but refrigeration by consumers during travel was not always adequate. The most favoured method of thawing frozen product at home was at room temperature for up to 12 h and the most common time period for storing raw meat in domestic refrigerators was up to two days (Gilbert et al. 2007).

An Italian study that evaluated the habits of pet owners found that most of the owners interviewed (81.2%, 151 out of 186) stored raw meat petfood in the freezer for no longer than one month. Half of pet owners allowed meat to defrost in the refrigerator and 44.6% defrosted the meat at room temperature (Morelli et al. 2021).

A New Zealand study has shown that the time required for frozen poultry (intended for human consumption) to reach even a minimum growth temperature of 7°C would be approximately 4 - 6 hours (McIntyre et al. 2007). Growth rates of pathogen such as *Salmonella* are slow at temperatures between 7 and 15°C, and not optimal until 35 - 37°C. It was therefore estimated that it would require another three hours at room temperature for poultry with an internal temperature of 7°C to reach an exterior temperature of 15°C, whereby there would be a higher potential for growth. Pathogens such as *L. monocytogenes* and *Y. enterocolitica*, however, may potentially grow better in these matrices at lower temperatures (7 and 15°C).

An Italian study of frozen raw meat petfood products purchased online, reported high values of total viable counts (TVC) (mean score of 29 products was 5.9×10^6 cfu/g) and *E. coli* and faecal coliforms (mean score of 29 products was 1.1×10^4 cfu/g (SD = 2.5×10^5 cfu/g) and 3.3×10^3 cfu/g (SD = 6.5×10^4 cfu/g), respectively) immediately after delivery (Morelli et al. 2020). Samples that were stored at 2°C for 72 hours had a significant increase in all parameters (TVC: $p < 0.1$; *E. coli* $p = 0.3$; faecal coliforms: $p = 0.4$). Samples stored at 7°C had significantly greater TVC ($p < 0.1$) compared with 2°C. Products such as lamb meat mixtures with tripe and bovine green tripe were the most contaminated (TVC 1.1 x 10^8 cfu/g) while bones and cartilaginous parts were the least contaminated (~5.0 - 9.0 x 10^4 cfu/g). The high number for TVC detected immediately after delivery indicated an increase in numbers during production, and prior to freezing and dispatch.

Other international studies that have evaluated the microbiological quality of commercially produced raw meat petfood, report high proportions (52 - 100%) of commercial raw meat foods exceeding EU thresholds of Enterobacteriaceae numbers (>3,000 cfu/1 g) (van Bree et al. 2018, Hellgren et al. 2019, Nüesch-Inderbinen et al. 2019, Morelli et al. 2020, McDonnell et al. 2022, Vecchiato et al. 2022). Due to the inherent nature of raw meat petfood products and the less stringent handling requirements compared with products approved for human consumption, these products may contain high levels of bacterial contamination (LeJeune and Hancock 2001). Raw meat petfood with poor microbiological quality may be carrying considerable numbers of potentially pathogenic bacteria and may reach even greater levels of bacterial contamination levels if not kept at proper refrigeration temperatures and used soon after defrosting (Morelli et al. 2020). Time-temperature abuse due to improper consumer food handling practices has been reported as one of the most common contributory factors in foodborne outbreaks (Roccato et al. 2015).

2.7 EXPOSURE ASSESSMENT

2.7.1 Transmission of foodborne pathogens to humans associated with raw meat petfood

Human illness caused by microbial pathogens, including antimicrobial resistant bacteria via raw meat petfood, can potentially occur via multiple transmission routes (Figure 2). This discussion document will focus on two predominant transmission routes:

- Human illness outbreaks directly attributed via the handing of raw meat petfood (petfood-to-person transmission).
- Human illness indirectly attributed to raw meat petfood, through contact with companion animals that consumed the raw meat petfood (pet-to-person transmission). Human infection may occur either through contact with the animal itself, via contaminated faeces, or from shared environments such as a household which an infected animal shares with the person.

Often it is not possible to unequivocally identify raw meat petfood as the source of a microbial pathogen in either the pet or the environment. It is important to note that there are a number of other potential exposure pathways of pathogens, shared by both humans and their pets, which can be interconnected within these two transmission routes. For example, dogs and cats that spend time outdoors can acquire pathogens from the soil, water, wild animals (such as hunting) or other pets and livestock. Pets and humans can also come into contact with pathogens already present in the house environment or in their food and can spread contamination to other surfaces (Hald and Madsen 1997, Lenz et al. 2009, Mughini Gras et al. 2013, Lambertini et al. 2016, Pomba et al. 2017).

In households where pets are fed raw meat-based diets, several food preparation activities may take place, including storage of raw, fresh or frozen animal products, thawing of frozen animal products, and handling and preparation of the feed, which can present various risks

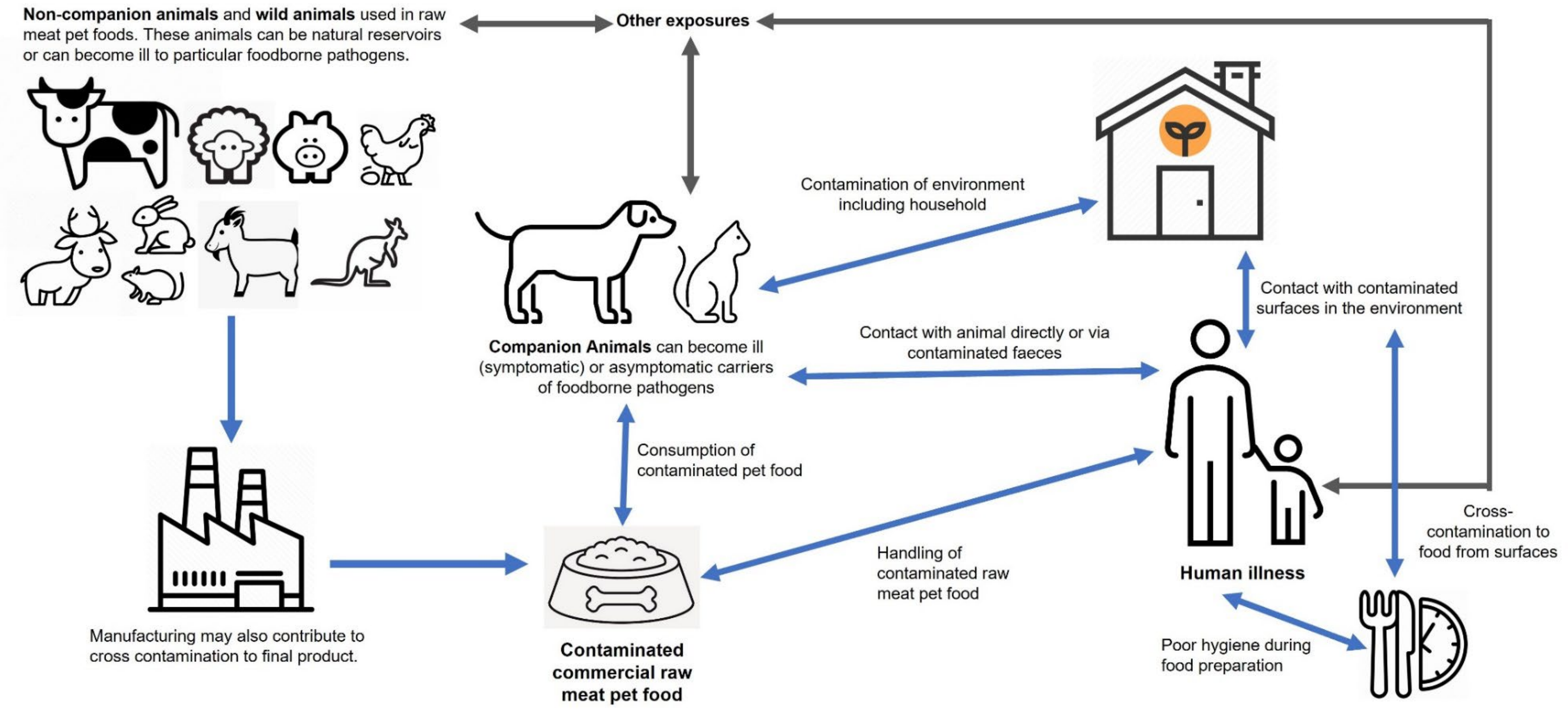

Figure 2: Direct and indirect transmission pathways for human illness of microbial pathogens attributed to commercial raw meat petfood

of cross contamination and multiple possible transmission routes to humans (Bulochova and Evans 2021b, a). It is also important to appreciate that the direction of transmission may also not be ascertained. It is possible that pets may be a source of infections for humans or *vice versa*, but both can have common exposures, including food and water (Mughini Gras et al. 2013, Bojanić et al. 2017).

While microbial contamination in environments frequented by pets has been extensively observed, there is limited evidence that supports a direct epidemiological link of zoonotic infection acquired exclusively through surfaces and objects that have previously come into contact with pets. Where case reports describe “contact with animals”, this can represent multiple routes of direct or indirect transmission (Lambertini et al. 2016). Moreover, the role and risk of raw meat petfood within these transmission routes are difficult to separate from other risks.

There are a number of studies that show an elevated risk of infection with enteric pathogens such as *Campylobacter* or *Salmonella* associated with direct contact with pets (Eberhart-Phillips et al. 1997, Doorduyn et al. 2010, Domingues et al. 2012, Mughini Gras et al. 2013, Lake et al. 2021).

Pathogen transmission, including multi-drug resistant strains, from dogs to humans due to direct-human contact or mediated by household environments has been reported (Morse et al. 1976, Sato et al. 2000, Wright et al. 2005, Hoelzer et al. 2011, Lambertini et al. 2016). For example, the risk of human campylobacteriosis has been reported to be higher due to common habits, such as humans that do not wash their hands after contact with their pets, allow pets to lick their face and hands, and allow their pets to sleep on the bed and sofa (and eat raw meat) (Kaindama et al. 2021, Iannino et al. 2022). Within pet-owning households with poor hygiene observance around animals, a higher risk of contracting *Salmonella* infection has been identified for young children and other high risk people (Stull et al. 2013).

2.7.2 Companion animal ownership in New Zealand and feeding of raw meat petfood

New Zealand has one of the highest rates of companion animal ownership in the world, with more than 4.35 million companion animals reported in 2020 (Companion Animals NZ 2020). New Zealanders overwhelmingly consider their companion animals to be members of the family, with cats being the most popular companion animal with 41% of households sharing their home with at least one cat. Dogs are the second most common companion animal in New Zealand, with 1.7 million dogs reported within 34% of households (Companion Animals NZ 2020).

Dogs and cats often live in close contact with their owners sharing their homes and immediate environment. There is a geographical difference in pet ownership across New Zealand, with pet ownership predominating in rural households, with 44% and 52% of rural households having at least one dog or cat, respectively. There has been a significant increase in the proportion of urban/city households owning at least one dog, from 27% in 2015 to 37% in 2020. A third (35%) of urban/city households share their home with a cat. (Companion Animals NZ 2020).

Approximately 83% of cats in New Zealand have access to both indoor and outdoor household environments. Cats are more likely to be indoor only in urban/city (17%) homes, followed by regional centres (16%), suburban and then rural (6%). Approximately 67% of dogs have access to both indoor and outdoor environments to households. Outdoor dog ownership is highest amongst regional centre households (29%). The percentage of households surveyed that identified their cat or dog as a working animal was 1 and 4%, respectively. A definition of a 'working animal' was not provided during the Companion Animals New Zealand survey, rather respondents would select that option if they chose to. However, Companion Animal New Zealand consider working animals as those used for production (for example dogs used for managing stock on farms), profit or service (for example, racing greyhounds, disability assist dogs, government dogs used within civil defence, the police, Customs Services etc) (Sarah Olson, Companion Animal New Zealand, Personal communication. 6 June 2023). Providing companionship, love and affection is the most important reason for acquiring a companion animal (Companion Animals NZ 2020).

Age and presence of children in the household both correlate with companion animal ownership, where 72 – 74% of households with children share their homes with a companion animal, while 60% of households without children share their home with at least one companion animal (Companion Animals NZ 2020). Dogs have a significantly higher incidence among younger households (under 25 years old; 47% compared with <41% for other age brackets), while cat ownership is highest amongst households aged 45 -54 with 53%.

The percentage of New Zealand pet owners who feed their pets with commercial raw meat food is unclear. A New Zealand survey of cat owners performed in 2019 reported that 31% (480 out of 1525) of respondents fed their cats raw meat, but thematic analysis of comments from respondents indicated that raw meat appears to be fed occasionally or as a treat. There were no specific questions or comments in the study regarding commercial raw meat petfood but various meat types (tuna, chicken, rabbits and fish) was noted in the respondents' responses (Forrest et al. 2021).

A recent New Zealand case-control study for yersiniosis indicated that among 242 controls, 135 (56%) and 125 (52%) individuals had recent contact with dogs or cats, respectively. Thirty-nine (16%) of the 242 people in the control group indicated that they handled fresh or frozen raw meat petfood or animal feed products (excluding dog rolls), and 13 (5%) indicated that other members of the household handled fresh or frozen raw meat petfood (ESR, unpublished data).

A source-attributed case-control study of campylobacteriosis in New Zealand reported 41% (245 out of 600) individuals notified with campylobacteriosis had indicated contact with pets at home, compared to 51% (341 out of 666) of individuals (controls) without illness (Lake et al. 2021).

An observational study of pet feeding practises in Australia, Canada, New Zealand, the United Kingdom (UK) and US, reported that many pets were offered raw foods (66% dogs and 53% cats, out of 3673 pet owner responses). Feeding of unconventional (raw, homemade and vegetarian) diets was also noted to have become more prevalent over the previous 10 years. International data are varied between countries, from approximately 16-23% in the US and Australia, to up to 60% of pet owners feeding their pets raw meat petfood in the Netherlands (Laflamme et al. 2008, Connolly et al. 2014, Anturaniemi et al. 2019, Thomas and Feng 2020).

2.7.3 Microbial hazard occurrence in raw meat petfood

New Zealand

Published prevalence data for microbiological hazards of interest, including antimicrobial resistant bacteria, in commercial raw meat petfood in New Zealand is limited.

One New Zealand study reported the prevalence of *Campylobacter* spp. from 50 arbitrarily selected raw petfood products from five commercial outlets located in Palmerston North (2010) (Bojanić et al. 2017). Of those samples, six were confirmed to have leaking packaging, two were sold after the use-by date and two had the same use-by date on which they were purchased. Samples containing tripe were common (n = 19), and 31 samples were from a single animal species source (11 beef, 11 chicken, five mutton, two venison and one pork and one of horse meat origin). The overall *Campylobacter* spp. prevalence was 28% (95% CI 16-43; n = 14), the majority of which (n = 11) were confirmed as *C. jejuni*. Products including poultry were more likely to be *Campylobacter* positive than non-poultry meat (Bojanić et al. 2017).

The study also included multi-locus sequence typing (MLST) of *C. jejuni* isolates obtained from the raw meat petfood and compared them with isolates obtained from animals, including dogs, reported in other studies. Nine different sequence types (STs) were identified amongst the petfood isolates and these were commonly found in the different meat types found in the petfood, suggesting the possibility for cross contamination in the manufacturing process.

Sequence types 45 and 474 were the most common genotypes in dogs, while ST48 was the most common type from cats. All three types were also identified in the raw petfood. These STs are also commonly detected in both chicken and humans in New Zealand.

International studies have also reported that the majority of *C. jejuni* genotypes observed in pets frequently occur also in humans and poultry, particularly ST45, which is the most common genotype reported around the world (Parsons et al. 2009, Mughini Gras et al. 2013, Amar et al. 2014).

Two New Zealand studies tested 50 home-killed raw meat diets fed to working farm dogs in Manawatū for *Salmonella* and *Campylobacter*. No *Salmonella* were detected in any diet sample nor faecal samples from tested dogs (Bojanić et al. 2019, Bojanić et al. 2022). Three (6%) raw meat feed samples were positive for *C. jejuni* and *C. rectus*, while multiple *Campylobacter* species and *C. jejuni* STs of both rare and common occurrence in several sources in New Zealand were identified from dog faeces, which supports the heterogenous exposures of farm dogs (Bojanić et al. 2019, Bojanić et al. 2022). Other international studies using MLST have reported a high diversity of STs in dogs, including strains frequently seen in humans and food (Parsons et al. 2009, Mughini Gras et al. 2013).

The only other published New Zealand study on commercial petfood, involved pet chews (Wong et al. 2007). Although, pet chews are not within the scope of this document, *Salmonella* was isolated from 6.7% (20 out of 300) domestically produced commercial pet chews. The pet chews were reported to be made from beef bones, bull’s pizzles and raw hides of unspecified animal species. *Salmonella enterica* subspecies *enterica* serotypes Typhimurium, Brandenburg and Enteriditis (PT9a) were isolated from beef bones and bulls’ pizzles, while *Salmonella* serotypes Havana, Mbandaka, Montevideo, Ohio and Orion were isolated from raw hide of unspecified animals.

International context

Table 4 summarises international studies (including New Zealand) on the prevalence of microbiological hazards of interest, in commercially available raw petfood. Caution must be taken as a number of these studies involve small sample numbers and variations in sampling procedures and analytical methods may contribute to the differences in prevalence for microbial pathogens reported.

Most studies report commercial raw meat petfood as frozen meat, obtained either directly from a supplier or online (with shipment). Two studies also reported on meat by-products used in raw meat petfood.

Salmonella are the most investigated microbial pathogens reported in raw meat petfood studies, with prevalence values ranging from 0 – 71.4% (Table 4). There are a number of studies that reported that the *Salmonella* obtained from commercial raw meat petfood were of clinical significance to humans, including (but not exclusively) *Salmonella* serotypes Typhimurium, Heidelberg, Hadar, Agona and Infantis (Finley et al. 2007). No genotyping information was provided in any of the studies. Some studies have indicated a higher prevalence of *Salmonella* in raw-meat products containing chicken, compared with other meat types (Finley et al. 2007, Fredriksson-Ahomaa et al. 2017, Solís et al. 2022).

Campylobacter has also been frequently reported in raw meat petfood studies with prevalence values ranging from 0 – 28.6%. *C. coli* and *C. jejuni* are recognised pathogens of humans and are common commensals of cattle, sheep, pigs and other species of domestic and wild animals (Facciolà et al. 2017, Shange et al. 2019).

Two studies reported a prevalence of 1.7 - 22.9% for *E. coli* O157:H7 in commercial raw petfood (Bottari et al. 2020, Treier et al. 2021). A 2021 Swiss study used PCR and culture methods to recover STEC from 41% of 59 samples of commercial raw meat petfood. Using whole genome sequencing (WGS), twenty different STEC serotypes were identified including clinically relevant O26:H11, O91:H10, O91:H1, O145:H28, O146:H21 and O146:H28 in commercial raw meat petfood diets (Treier et al. 2021). A core-genome MLST comparison of sequenced STEC ST33, ST442 and ST641 from the raw meat products found no clustering of these isolates to clinical STEC isolates available from the Swiss National Reference Centre for Enteropathogenic Bacteria. The authors indicate that the high occurrence of STEC in raw meat petfood poses an important health risk for persons handling raw petfood and/or those with close contact to pets fed on these diets, especially as the infectious dose is low and STEC can cause potentially severe disease manifestations (Treier et al. 2021).

Studies have reported *L. monocytogenes* prevalence in commercial raw meat petfood to range between 0.2 – 90.5%. Even though there have been petfood recalls in the US due to the presence of *L. monocytogenes* (Section 3.5), there are very limited data for this pathogen in petfood in general. A study from Ireland that tested meat by-products intended for raw petfood for dog kennels reported *L. monocytogenes* as the most frequently (19.4%) isolated pathogen in both fresh and frozen product (McDonnell et al. 2022). The authors indicated that the results were not unexpected as *L. monocytogenes* is widespread in Irish dairy and beef farms (Fox et al. 2009). In addition, knackeries (a petfood facility that processes animals that die on farm as a result of an injury or non-notifiable disease) do not undertake the same hygiene practises as establishments that produce meat for human consumption (McDonnell et al. 2022).

Table 4: Selected published microbiological surveys for commercial raw petfood

Country	Year sampled	Feed types/name	No. tested	Analyte: No. positive (%)	Other findings	Reference
New Zealand	2010	Raw petfood. Commercial. Frozen & fresh.	50 (Frozen: 12, Fresh: 38)	*Campylobacter* spp: 14 (28%) *C. jejuni*: 11 (22%)	*C. lari* and *C. coli* also detected	(Bojanić et al. 2017)
Canada	2003-2004	Raw meat dog food. Commercial. Frozen	166	*Salmonella:* 36 (22%)	Serotypes Heidelberg, Hadar, Infantis, Agona, I:R-O:r:1,2, I:4,12:-:-, I:R-O:z10:enx, Albert, Thompson, Schwarzengrund, Kentucky, Typhimurium, Brandenburg, Meleagridis, Mbandaka. Isolates resistant to 12 of the 16 antimicrobials tested observed	(Finley et al. 2008)
Canada	Not stated	Raw food petfood. Commercial. Frozen	25	*E. coli*: 16 (64%) *Salmonella*: 5 (20%) *Campylobacter* spp: 0		(Weese et al. 2005)
Chile	Not stated	Raw meat-based diets. Commercial	31	*Salmonella*: 8 (26%) *L. monocytogenes*: 6 (19%) *Campylobacter* spp: 0	Homemade diets and faecal samples from dogs tested in study.	(Solís et al. 2022)
Egypt	Not stated	Raw petfood. Unclear if commercial	20	*E. coli:* 7 (35%) *Salmonella*: 1 (5%)	Dry and wet petfood also tested in study	(Azza et al. 2014)
Finland	2015-2016	Raw meat-based diets. Commercial. Frozen	88	*Salmonella*: 2 (2%) *Campylobacter* spp. 13 (15%) *Y. enterocolitica*: 10 (11%)	PCR only	(Fredriksson-Ahomaa et al. 2017)
Germany	2017	Raw meat-based diets. Commercial. Frozen.	10	*Salmonella:* 2 (20%)		(Vecchiato et al. 2022)
Ireland	2016	Meat by-products for raw petfood.	521 (Frozen: 208, Fresh: 313)	*Salmonella:* 77 (15%)	Serotypes Dublin, Typhimurium, Montevideo, Monophasic Typhimurium, Braenderup, Anatum, Agama	(McDonnell et al. 2022)
				Campylobacter spp: 12 (2%)	*C. coli*, *C. jejuni* and *C. fetus* subsp. *intestinalis*	
				L. monocytogenes: 101 (19%)		
				E. faecalis: 271 (52%)	AMR: tetracycline resistance most common, followed by chloramphenicol and erythromycin. Three ESBL *E. coli* also isolated	
				E. faecium: 127 (24%)	Testing at kennels also performed	

Country	Year sampled	Feed types/name	No. tested	Analyte: No. positive (%)	Other findings	Reference
Italy	Not stated	Biologically appropriate raw food diets. Commercial. Frozen	21	*E. coli* O157:H7: 5 (24%) *Salmonella*: 15 (71%) *L. monocytogenes:* 19 (91%) *Campylobacter* spp: 6 (29%)		(Bottari et al. 2020)
Italy	2017	Foodstuff meat products (poultry, pork and beef) for petfood. Fresh.	112	*E. coli:* 110 (98%) *Salmonella*: 10 (9%)	18.2% of *E. coli* and 20% of *Salmonella* isolates were antibiotic resistant *Salmonella* Typhimurium and *Salmonella* Derby. *Salmonella* recovered from poultry and pork - not beef.	(Bacci et al. 2019)
Italy and Germany	Not stated	Raw dog food. Commercial (online). Frozen	29	*Salmonella*: 0 *L. monocytogenes*: 19 (66%) *Y. enterocolitica:* 3 (10%)		(Morelli et al. 2019)
Japan	2016-2017	Raw meat-based diets. Commercial. Frozen	60	*Salmonella*: 7 (12%)	Serotypes Infantis, Typhimurium, Schwarzengrund and two serotypes unidentifiable. *Salmonella* isolates with multi-drug resistance	(Yukawa et al. 2022)
Netherlands	Not stated	Raw meat-based diets. Commercial. Frozen	35	*E. coli*: 28 (80%) ESBL *E. coli:* 28 (80%) *E. coli* O157:H7: 8 (23%) *Salmonella*: 7 (20%) *L. monocytogenes:* 19 (54%) *T. gondii:* 2 (6%)	*T. gondii* detected by PCR	(van Bree et al. 2018)
Netherlands	Not stated	Raw cat food. Commercial. Frozen and 2 non-refrigerated	18	ESBL Enterobacteriaceae: 14 (78%)	20 non-raw samples all negative	(Baede et al. 2017)
Sweden	2017	Raw meat-based diets. Commercial	60	*Salmonella*: 4 (7%) *Campylobacter*: 3 (5%)		(Hellgren et al. 2019)
Sweden	Not stated	Raw dog food containing poultry. Commercial. Frozen	39	*E. coli*: 39 (100%) ESCR *E. coli*: 9 (23%)		(Nilsson 2015)
Switzerland	2018	Raw meat-based diets. Commercial.	51	ESBL *E. coli*: 31 (61%) *Salmonella*: 2 (4%)	*S.* monophasic Typhimurium 4,12:i:-, *S.* London	(Nüesch-Inderbinen et al. 2019)
Switzerland & Germany	2018 & 2020	Raw meat-based products. Commercial. Frozen	59	STEC: 24 (41%)	PCR and culture used. *E. coli* O91:H14, O146:H21, O76:H19, O113:H21, O146:H28, O168:H8, others (incl. O145:H28, O26:H11) Six STEC isolates with two or more transmissible AMR genes	(Treier et al. 2021)

Country	Year sampled	Feed types/name	No. tested	Analyte: No. positive (%)	Other findings	Reference
Thailand	2019-2020	Raw petfood. Commercial	17 (including 2 freeze dried)	*E. coli*: 7 (41%) *Salmonella*: 9 (53%) *L. monocytogenes:* 3 (18%) *Campylobacter:* 0		(Kananub et al. 2020)
US	2010-2012	Raw dog and cat food. Commercial (online), frozen	576	*E. coli* O157:H7: 10 (2%) *Salmonella*: 15 (3%) *L. monocytogenes*: 32 (6%)		(Nemser et al. 2014)
US	2010-2011	Raw meat diets. Commercial. Raw-frozen, dehydrated, freeze-dried.	60	*Salmonella*: 4 (7%)		(Mehlenbacher et al. 2012)
US	2002	Raw meat dog food (beef, lamb, poultry or turkey). Commercial. Frozen	240	*E. coli:* 143 (60%) *Salmonella*: 17 (7%) *T. gondii:* 0	PCR used to test for *T. gondii*	(Strohmeyer et al. 2006)
US	Not stated	Raw meat-based diets (beef & poultry as primary protein). Commercial.	21	*E. coli:* 14 (66%)	Among 191 *E. coli* isolates: 20 were STEC. 19 conventional diets were negative	(Gibson et al. 2022)
US	Not stated	Raw food diet. Commercial.	2	*E. coli* O157:H7: 1 (50%) *Salmonella* (0%)		(Freeman and Michel 2001)

Abbreviations: United States of America (US), Polymerase chain reaction (PCR), Extended spectrum beta-lactamases (ESBL), Extended spectrum cephalosporin-resistant (ESCR), Antimicrobial resistance (AMR), Shiga-toxin producing *E. coli* (STEC).

Several international studies have reported antimicrobial resistant (AMR) bacteria, including those which were multi-drug resistant, amongst isolates of *Salmonella*, enterococci and *E. coli* obtained from commercial raw petfood (Table 4). A 2019 Swiss study reported that AMR bacteria were found in 62.7% of raw meat-based diets and the majority of isolates were resistant to third generation cephalosporins due to the production of extended-spectrum β-lactamases (ESBLs) (Nüesch-Inderbinen et al. 2019).

The study of McDonnell et al. (2022) from Ireland, also reported a high level of AMR in meat by-product, kennel environment, and equipment, including multi-drug resistance (defined as resistance to three or more antimicrobials) in three (9.1%) of 33 *Salmonella* isolates obtained from meat by-product samples and was not observed in environmental samples. Resistance to at least one antimicrobial was observed for 29 (85%) out of 34 *Enterococcus faecalis* and 22 (92%) out 24 *Enterococcus faecium* (isolated from environmental samples only). In comparison, resistance to at least one antimicrobial was observed for 28 (76%) out of 37 and 25 (63%) out of 40 *E. coli* isolated from meat-by product and environmental samples, respectively. *E. coli* isolated from the environments of kennels adjacent to the knackeries were also found to have similar AMR patterns. It was hypothesised that the high level of resistance to tetracyclines, sulphonamides, trimethoprim and ampicillin observed amongst *E. coli* isolates may be due to selective pressure of antimicrobial treatment of fallen stock and/or more frequent use of antimicrobials within veterinary medicine. This may have resulted in AMR *E. coli* strains colonising the bovine gastrointestinal tract and subsequent transmission to dogs after feeding raw meat products from this type of animal source.

2.7.4 Other relevant New Zealand prevalence data for microbial hazards in raw meat

Food-producing animals are the major reservoir for the microbial hazards of interest in this discussion document. Details of these microbial pathogens within primary production for human consumption and have been discussed in detail in various Risk Profiles prepared by ESR for MPI (Appendix A, Table 19). Additional studies with relevant prevalence data that are not captured within the Risk Profiles are outlined in Table 5.

Prevalence data for key pathogens within the meat processing chain for human consumption are available via the National Microbiological Database (NMD) Programme. This programme involves a standardised microbiological sampling testing programme to provide ongoing monitoring of microbiological process controls across all operators who process red meat or poultry intended for human consumption (Ministry for Primary Industries 2023). Product type tested and frequency of testing under the NMD programme, differs between animal species. However, testing often targets carcass, primal cuts and/or bulk meat at the end of primary processing. For red meat processing, the NMD programme monitors Aerobic Plate Counts (APC) only for ovine and APC in addition to generic *E. coli* testing for bovine, caprine, cervine, porcine, bobby calf and ratites. *Salmonella* are tested for in bovine, caprine, bobby calf and ratites. For poultry, the NMD programme monitors for *Salmonella* and *Campylobacter,* with independent sampling programmes for ducks, end-of-lay chickens, meat chickens and turkeys (Ministry for Primary Industries 2023).

In addition, Overseas Market Access Requirements (OMAR) outline testing protocols for seven serogroups of STEC (Top 7) constituting *E. coli* O157:H7, O26, O45, O103, O111, O121, and O145 that are considered adulterants in raw bulk manufacturing beef meat, including veal, in the US. Typing of any isolates of *E. coli* O157:H7 that have been detected

Table 5: Additional prevalence data of microbial pathogens and/or indicator bacteria in raw meat intended for human consumption in New Zealand that are not captured in Risk Profiles[1]

Animal	Meat product (No. sample)	Pathogen	Year of assessment (Country)	No. positives samples and findings	Reference
SHEEP	New-season lamb (n = 53) Late-season lamb (n = 50) Mutton carcasses (n = 50)	STEC Top 7	2017-2018 (NZ)	No isolation performed. Enrichments confirmed for Top 7 STEC using NeoSeek™[2] New-season lamb: 20 (40%) Late-season lamb: 9 (17%) Mutton: 8 (16%) Younger lambs are more likely to carry STEC than older lambs or mutton.	(Mills et al. 2018a, Mills et al. 2018b)
	New-season lamb (n = 53) Late-season lamb (n = 50) Mutton carcasses (n = 50)	*Salmonella*	2017-2018 (NZ)	New-season lamb: 3 (6%). Serotypes Bovismorbificans and Typhimurium Phage type 56 variant. Late-season lamb and mutton: 0	
	Hogget trim carcass (n = 50) Lamb trim carcass (n = 36) Mutton carcasses (n = 35)	*C. jejuni/coli*	2017-2018 (NZ)	PCR screening results for *Cj* and *Cc*. New-season lamb 4 (11%), late-season lamb 28 (56%), mutton: 7 (20%) Enumeration of trim samples: <10 cfu per gram	(Rivas et al. 2021a)
CATTLE (INCLUDING VEAL)	Beef carcass trim for N60 programme[3] (n = 239) Screen positive-bobby veal trim enrichments (n = 17)	STEC Top 7	2021 (NZ)	39 beef carcass samples were confirmed culture positive for STEC Top 7 serotypes. O103 (n =1), O26 (n = 21) and O157 (n = 1). 17 enrichments that were Neoseek™ screen positive for STEC O157 selected for culture confirmation. Eight were confirmed to have STEC O157.	(Wright et al. 2022)
	Bobby veal trim N60 samples 2019 (n = 457) 2020 (n = 594)		2019 & 2020 (NZ)	2019: 56 (12.3%) confirmed positive 2020: 86 (14.5%) confirmed positive	(New Zealand Food Safety Ministry for Primary Industries 2021)
PIGS	Raw pork mince at retail (n = 30)	*Y. enterocolitica*	2019 (NZ)	7 (23%). YE bioserotypes 2/3, O:5, 27 and O:9 and 4, O:3	(Rivas 2020)
	Porcine carcass swab rinsates (n = 40)		2019-2020 (NZ)	6 (15%). YE bioserotypes 2/3, O:5, 27 and O:9 and 4, O:3. Close genetic relationships between isolates from carcass swabs and retail samples.	
POULTRY – EGG LAYERS[4]	Egg layer farm samples from 28 farms (total of n = 323 samples including faeces, dust and boot or manure belt swabs and packhouse swabs)	*Salmonella*	2016 (NZ)	12 of 28 farms had at least one positive sample. 43 out of 323 (13%) of *Salmonella* positive samples, including dust samples (19 out of 67), boot and manure belt swabs (11 of 67, 16%) faeces (7 of 67; 10%). Serotypes Infantis, Thompson, Typhimurium, Anatum, Mbandaka.	(Kingsbury et al. 2019)

Animal	Meat product (No. sample)	Pathogen	Year of assessment/Country	No. positives samples and findings	Reference
KANGAROO	Kangaroo carcasses *E. coli* (n = 150; 2002, n =385; 2004) *Salmonella* (n = 60, 2002; n = 385, 2004)	*E. coli* *Salmonella*	2002-2004 (Australia)	*E. coli* in 2002: 49 (33%). In 2004: 43 (11%) *Salmonella:* 0 (2002). In 2004, 4 (1%). Serotypes Muenchen and Singapore	(Holds et al. 2008)
	Minced kangaroo meat (n = 50) 2002			*Salmonella:* 9 (18%). Serotypes Muenchen, Havana	
	Kangaroo carcasses (n = 836).	*E. coli* *Salmonella*	2003 - 2006 (Australia)	*E. coli*: 13.9% (based on most-probable number method) *Salmonella*: 7 (1%)	(Eglezos et al. 2007)
	Kangaroo carcasses (n = 81)	*Salmonella*	Not stated (Australia)	9 (11%). Serotypes Bahrenfeld, Binza, Onderstepoort	(Bensink et al. 1991)

Abbreviations: New Zealand (NZ), *Campylobacter jejuni* (*Cj*), *C. coli* (*Cc*), colony forming units (cfu), Shiga toxin-producing *E. coli* (STEC) – Top 7 (serotypes include O157, O26, O45, O103, O111, O121, O145), *Yersinia enterocolitica* (YE).

Notes: [1] Studies with prevalence data on kangaroo meat are from Australia.

[2] NeoSeek™ STEC (Neogen, Langsing, US) is a commercial multiplex method utilising more than 80 genetic targets to identify STEC Top 7 (Hosking et al. 2020).

[3] 2021 annual report only for the N60 Top 7 STEC regulatory programme undertaken to fulfil requirements under the MPI, Overseas Market Access Requirement: United States of America, amendment 21, May 2021, Part 2, Schedule 1. The numbers stated represent only a portion of the total enrichments that would be initially screened for Top 7 STEC and then sent on for confirmation using NeoSeek™.

[4] The focus of this study was *Salmonella* contamination on commercial egg layer farms to understand the risk of exposure of *Salmonella* on eggs. Although eggs are out of scope for this discussion document, end of lay birds are processed for raw meat petfood.

in either beef or veal during routine monitoring in New Zealand must also be performed using WGS, with the provision of typing profiles to US regulators upon request (Wright et al. 2022).

Primary processors of meat intended for petfood are not required to participate in the NMD programme or the US OMAR STEC Top 7 testing. However, the data may be informative on the prevalence of these pathogens at the primary processing level, as well as on by-products from meat processing intended for human consumption that is diverted to petfood, including raw meat petfood.

The number of *Salmonella* detections recorded within the NMD programme between 2011 and 2022 for poultry and red meat samples is outlined in Table 6 and Table 7, respectively. Since 2011, *Salmonella* prevalence in NMD programme samples for poultry and red meat samples are low (less than 1%). In 2021, *Salmonella* Enteritidis (SE) ST11 was detected during NMD programme testing on a raw broiler chicken carcass from a large-scale poultry meat processor (Ministry for Primary Industries 2021). This represented the first detection of this serotype from New Zealand poultry. The ST11 isolate formed a close genetic cluster (less than five single nucleotide polymorphism differences) with an ongoing cluster of human cases from the North Island, that dated back to 2019 (Pattis et al. 2022). Sequence type 11 was also detected in additional poultry operations, one of which was a major supplier of day-old chicks and hatching eggs for the poultry meat and egg industries in New Zealand and the other a rearer of pullets for egg-laying (Ministry for Primary Industries 2021). Both the initial broiler and rearer detections were from farms supplied by the hatchery on the same day. The working assumption was that the hatchery was the source of SE in downstream operations and therefore further infections within connected poultry producers (egg laying, broiler, or rearer) was likely.

During the MPI formal response phase, products from broiler farms where SE was detected could not be released for human consumption without treatment by heat (cooking) or antimicrobial wash. Three of the broiler farms voluntarily depopulated infected flocks and one diverted processed chicken meat to cooked petfood (Ministry for Primary Industries 2021).

Available data for STEC Top 7 show a prevalence of 12.3 and 14.5% in bobby veal trim samples tested in 2019 and 2020 (Table 5). Bovine and bobby veal trim that fail STEC testing can be redirected into the petfood market, but it is more likely to be redirected to alternative markets that do not require STEC testing or the domestic market for human consumption (Kate Thomas, MPI, Personal communication. 8 June 2023). The US OMAR STEC Top 7 requirements are not applicable for lamb or mutton, but studies have shown STEC Top 7 prevalence ranging between 16% for mutton carcasses and 40% for new-season lamb carcasses. Testing of the same samples also indicated a prevalence of *Salmonella* of 6% in new-season lamb but 0% in mutton or late season lamb. For *Campylobacter,* the overall prevalence in these samples based on PCR detection was 33%, with prevalence ranging between 11% for new-season lamb and 56% for late-season lamb (Table 5).

Table 6: *Salmonella* detections from National Microbiological Database (NMD) programme testing of poultry samples (2011 – 2022)

Year	Meat chicken samples			Duck and turkey samples			End of Lay samples		
	Samples	Detections	% Detected	Samples	Detections	% Detected	Samples	Detections	% Detected
2011	2040	5	0.2%	NT	NT	NT	NT	NT	NT
2012	2110	14	0.7%	NT	NT	NT	NT	NT	NT
2013	2093	5	0.2%	NT	NT	NT	NT	NT	NT
2014	2136	4	0.2%	NT	NT	NT	NT	NT	NT
2015	2177	1	0.0%	NT	NT	NT	NT	NT	NT
2016	2208	2	0.1%	45	0	0.0%	49	0	0.0%
2017	2209	1	0.0%	253	2	0.8%	253	0	0.0%
2018	2202	2	0.1%	253	4	1.6%	301	0	0.0%
2019	2144	0	0.0%	255	3	1.2%	276	0	0.0%
2020	2116	1	0.0%	191	2	1.0%	258	0	0.0%
2021	2114	1 (1)[1]	0.0%	179	2	1.1%	220	1	0.5%
2022	2087	0	0.0%	177	3	1.7%	151	1	0.7%
Total	**25636**	**36**	**0.1%**	**1353**	**16**	**1.2%**	**1508**	**2**	**0.13%**

Abbreviations: Not tested (NT)
Notes:[1]The number in brackets indicates the number of detections that were *Salmonella* Enteritidis.

Table 7: *Salmonella* detections from National Microbiological Database (NMD) Programme testing of red meat samples (2011 - 2021)

Year	Bobby calf fresh carcass, bulk meat and primal cut samples			Bovine fresh carcass and bulk meat[1] samples			Caprine fresh carcass samples			Ratite fresh carcass samples		
	Samples	Detections	% Detected	Samples	Detections	% Detected	Samples	Detections	% Detected	Samples	Detections	% Detected
2011	3860	22	0.6%	2419	2	0.1%	427	1	0.2%	14	0	0.0%
2012	3990	13	0.3%	1290	0	0.0%	286	0	0.0%	8	0	0.0%
2013	4003	14	0.3%	1126	0	0.0%	325	1	0.3%	10	0	0.0%
2014	4087	14	0.3%	1013	0	0.0%	386	0	0.0%	14	0	0.0%
2015	3900	16	0.4%	959	0	0.0%	387	0	0.0%	12	0	0.0%
2016	3185	10	0.3%	951	1	0.1%	388	1	0.3%	20	0	0.0%
2017	2975	18 (1)[2]	0.6%	925	1	0.1%	390	0	0.0%	60	0	0.0%
2018	2875	11	0.4%	990	0	0.0%	370	0	0.0%	40	0	0.0%
2019	2805	16	0.6%	980	0	0.0%	325	0	0.0%	35	0	0.0%
2020	2425	12	0.5%	890	0	0.0%	290	0	0.0%	20	0	0.0%
2021	2735	12 (1)	0.4%	1075	0	0.0%	260	0	0.0%	40	0	0.0%
2022	2500	9	0.4%	1050	0	0.0%	185	0	0.0%	20	0	0.0%
Total	**39,340**	**167**	**0.4%**	**13,668**	**4**	**0.0%**	**4,019**	**3**	**0.1%**	**293**	**0**	**0.0%**

Notes:[1] Bovine bulk meat was only sampled in 2011.
[2] The number in brackets indicates the number of detections that were *Salmonella* Enteritidis.

Limited prevalence data are available for pork and meat from wild animals processed in New Zealand. Although *Y. enterocolitica* has been detected on pig carcasses during processing and in retail pork in New Zealand (Table 5), very small amounts of pork are used in raw meat petfood (Table 2 and Table 3). As a result, it may be assumed that the risk of *Y. enterocolitica* in raw meat petfood is low.

Studies from Australia have indicated that the prevalence of *Salmonella* on kangaroo carcasses is 0 – 11%, with *Salmonella* serotypes that are not commonly associated with human illness (Table 5). It is unclear whether the processing of kangaroo for human consumption differs to that used for petfood.

Fundamentally, there are limited New Zealand prevalence data for any of the microbial hazards in commercial raw petfood. Available data from studies involving raw meat processed for the human consumption, suggest that these microbial pathogens may also be present during primary processing of meat for petfood production. The critical control steps that exist within the primary processing of meat for human consumption may not occur during primary and secondary petfood processing. It is plausible that these pathogens may be more prevalent in raw meat petfood.

3 EVALUATION OF ADVERSE HEALTH EFFECTS

Key findings

- In the last 15 years, there have been no reported human illness outbreaks attributed to raw meat petfood in New Zealand. Available surveillance data on risk exposures from questionnaires administered to cases indicate that the numbers of notified human illness cases (for the microbial hazards in scope that are notifiable) that handled raw meat petfood are very low. However, the questionnaires administered do not contain specific questions on raw meat petfood and so data are likely to only occur in comment fields. The current response rate for the questionnaires is low.
- Internationally, outbreaks of human illness (*Salmonella* and STEC O157:H7) attributed to raw meat petfood have been reported, with two outbreaks identified as a part of public health surveillance, involving WGS to identify clusters of cases and follow-on investigations. It is likely that most raw meat petfood feeding associated human illness cases will be sporadic, and thus not investigated further for a cause. This indicates a potential area of under-recognition and under-reporting.
- International data show an association between feeding pets raw meat-based diets and microbial pathogens shed by these animals. Symptomatic or asymptomatic shedding of pathogens presents a source of environmental contamination that can potentially lead to human and animal illness. There are limited data for New Zealand in this area.
- In New Zealand, animal health surveillance data for salmonellosis between 2011 and 2021 show a geographical distribution of companion animal cases that differs from the distribution of cases occurring in dairy cattle. In particular, *Salmonella* Brandenburg and *Salmonella* Give have previously distinct geographical distribution in cattle, yet companion animal illness of the same serotypes is mostly located in urban locations geographically remote to those of cattle. This poses a question as to whether contaminated meat products consumed by companion animals are posing a risk for salmonellosis in these animals.
- The New Zealand animal health surveillance data for salmonellosis in 2022, showed an increase in *Salmonella* Livingstone and *Salmonella* Agona in companion animals. The rate of increase of these serotypes was not observed within bovine salmonellosis cases in 2022. It is unclear as to whether these serotypes are less pathogenic for bovine animals or whether there are unrecognised sources of infection that may be contributing to the increase of these serotypes in companion animals.
- Further genetic typing of *Salmonella* isolates obtained during surveillance programmes may prove useful in ascertaining genetic relationships between isolates from production and companion animals in the first instance.
- No recalls or border rejections for petfood were identified for New Zealand between 2015 to 2023. The US has recorded multiple recalls for raw meat petfood produced in the US and other countries, due to the presence of microbial hazards, including *Salmonella*, *L. monocytogenes* and *E. coli* O157, some of which were associated with human illness outbreaks.

- Although contact with animals may present as a risk factor for human disease by some of these microbial hazards, the extent by which raw meat petfood contributes as a vehicle within the multiple transmission routes of infection cannot be assessed with current information.

3.1 DISEASE CHARACTERISTICS

This discussion document addresses the following microbial pathogens as hazards:

- *Salmonella enterica* (non-typhoidal)
- *Campylobacter* spp.
- *L. monocytogenes*
- STEC
- *Y. enterocolitica*
- *T. gondii*

Disease characteristics and the dose-responses of these microbial pathogens are included in Appendix A, Table 18, the MPI website,[14] and previously discussed at length in previous Risk Profiles, Appendix A, Table 19.

Toxoplasmosis, the disease caused by *T. gondii,* is not a notifiable disease for New Zealand, while diseases attributed to the other microbial hazards of interest are notifiable.[15]

3.2 OUTBREAKS OF HUMAN ILLNESS OF MICROBIAL HAZARDS DIRECTLY ATTRIBUTED TO RAW MEAT PETFOOD

3.2.1 New Zealand

In the following sections the definition of an outbreak used in *Guidelines for the Investigation and Control of Disease Outbreaks* (ESR 2012) has been adopted:

“a localised increase in cases of illness clearly in excess of that normally expected”.

While outbreaks are most often of infectious diseases, localised increases in cases of non-infectious diseases or adverse health effects may also occur. Due to the timeframes involved, increases in the incidence of chronic diseases are not usually referred to as outbreaks.

A search of the New Zealand National Notifiable Disease Database (EpiSurv)[16] undertaken in April 2023, showed that raw meat petfood had not been recorded as a confirmed or possible food source for any pathogen related outbreak or individually notified illness for the previous 15 years (2008 to 2022) in New Zealand.

Note that, due to the incubation period for microbiological illnesses, it can be difficult to determine the source of foodborne illness. The original food causing the illness is unlikely to be available for testing, people may have trouble recalling their previous diet and there can

[14] https://www.mpi.govt.nz/science/food-safety-and-suitability-research/food-risk-assessment/foodborne-hazard-data-sheets/ (Accessed 4 April 2023)
[15] https://www.health.govt.nz/system/files/documents/pages/schedule-of-notifiable-diseases-updated-jun22.pdf (Accessed 3 April 2023)
[16] https://surv.esr.cri.nz/episurv/ (Accessed 14 April 2023)

be multiple possible foods consumed and other non-food sources. The source of a common source outbreak is more likely to be found in larger outbreaks, using epidemiological investigations.

3.2.2 International context

Internationally, there has been two published outbreaks involving *Salmonella* (including multi-antimicrobial resistant isolates) and two outbreaks of STEC O157:H7 linked to commercial raw meat petfood products in North America and the UK (Table 8). The two STEC O157:H7 outbreaks were identified through the national surveillance process where a cluster of cases were genetically identified using WGS (Kaindama et al. 2021).[17] These cases were followed up with interviews which resulted the identification of raw petfood or contact with pets fed the raw petfood as common exposures. Subsequent testing of implicated raw meat products was also undertaken to confirm the source.

A *Salmonella* outbreak implicated petfood as a source among 358 human illness cases spanning across 42 states in the US and Canada from 2017 to 2019.[18] Of the 200 interviewed ill cases, four cases had reported becoming ill after pets in their homes ate raw ground turkey petfood. Epidemiological and laboratory evidence indicated multiple products that incorporated raw turkey meat, including raw petfood. *Salmonella* Reading was identified, and some strains obtained from human cases contained antimicrobial resistance genes towards ampicillin (52% of all 487 isolates), streptomycin (32%), sulfamethoxazole (31%), tetracycline (32%), kanamycin (3.4%), gentamicin (0.6%), nalidixic acid (0.4%), ciprofloxacin (0.4%), trimethoprim-sulfamethoxazole (0.4%) and fosfomycin (0.2%). Most (99%) of the human infections in the outbreak were susceptible to the antibiotics that are commonly used for treatment. The outbreak strain was identified in raw meat petfood and other products and within multiple processing establishments. The data indicated that the strain was present in live turkey but a single common supplier of raw turkey products or of live turkeys that could account for the whole outbreak was not identified.

Another *Salmonella* outbreak occur between 2018 and 2019 and caused 129 human illness cases spanning 32 states in the US. Epidemiological and laboratory evidence indicated multiple raw chicken products, including raw petfood. *Salmonella* Infantis was identified, and one person reported illness following their pet ate raw ground chicken petfood. The outbreak strain was identified in samples from raw chicken products from 76 slaughter and/or processing establishments and were genetically related to those isolates from sick individuals. Using WGS, the outbreak strains were found to possess resistance genes for multiple antibiotics (including ampicillin, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, nalidixic acid, streptomycin, sulfamethoxazole, tetracycline and trimethoprim-sulfamethoxazole), and susceptibility testing of seven isolates confirmed these results.[19]

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[17] https://recalls-rappels.canada.ca/en/alert-recall/carnivora-fresh-frozen-patties-dogs-and-cats-recalled-due-ecoli-contamination (Accessed 23 February 2023)
https://www.canada.ca/en/public-health/services/public-health-notices/2020/outbreak-e-coli-frozen-raw-pet-food.html (Accessed 23 February 2023)
[18] https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 18 April 2023)
[19] https://www.cdc.gov/salmonella/infantis-10-18/index.html (Accessed 7 June 2023)

Table 8: Reported international outbreaks of enteric pathogens in human cases linked to raw petfood

Year	Country	Pathogen	Case details	Details of petfood attributed to cases	Reference
2020	Canada	STEC O157:H7	5 cases (2 hospitalised)	All cases reported exposure to Carnivora brand frozen raw petfood [recalled], or to dogs fed this raw petfood before their illness occurred. Outbreak identified during surveillance as case isolates had similar genetic fingerprints.	https://recalls-rappels.canada.ca/en/alert-recall/carnivora-fresh-frozen-patties-dogs-and-cats-recalled-due-ecoli-contamination. https://www.canada.ca/en/public-health/services/public-health-notices/2020/outbreak-e-coli-frozen-raw-pet-food.html (Accessed 23 February 2023)
2018-2019	US and Canada	*Salmonella* Reading (multidrug resistant)	358 cases (133 hospitalisations, one death).	Of the 200 interviewed cases, four cases reported illness after pets in their home ate raw ground turkey petfood Various raw turkey products implicated including: Woody's Petfood Deli – Raw Turkey petfood [recalled] Raws for Paws – Ground Turkey Petfood [recalled]	https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 23 February 2023)
2019	US	*Salmonella* Infantis (multidrug resistant)	129 cases (25 hospitalisations, one death).	Epidemiological and laboratory evidence indicated various raw chicken products implicated including raw chicken petfood (Darwin's) [Recalled]. One person reported they got sick after their pet ate raw ground chicken petfood.	https://www.cdc.gov/salmonella/infantis-10-18/index.html (Accessed 7 June 2023)
2017	UK	STEC O157:H7	4 cases (3 cases hospitalised and one death)	Three cases had been exposed to dogs fed on a raw meat-based diet, specifically tripe (two cases purchased tripe from the same supplier). STEC O100:H30 was isolated from raw tripe product from the implicated supplier but genetically different to case isolates. Outbreak identified during surveillance as case isolates had similar genetic fingerprints.	(Kaindama et al. 2021)

Abbreviations: Shiga toxin-producing *E. coli* (STEC), United States of America (US), United Kingdom (UK)

Although pet treats are out of scope for this discussion document, there have been several human salmonellosis outbreaks in the US and Canada that have been attributed to pet treats (Appendix D), highlighting a risk of handling of contaminated petfood for human salmonellosis, particularly for young children who often predominate within the human cases in these outbreaks.

3.3 HUMAN ILLNESS ATTRIBUTED TO MICROBIAL HAZARDS AND HANDLING OF PETFOOD/RAW MEAT PETFOOD

3.3.1 New Zealand

In New Zealand, notified human cases may be sent or interviewed with a questionnaire by their local public health authorities to obtain information on potential risk factors associated with their illness. Some high-risk food exposure may also be collected, and this information is recorded in the EpiSurv database.[20]

The current standard EpiSurv case report forms for enteric diseases (including campylobacteriosis and salmonellosis), listeriosis and STEC infection do not have specific questions regarding petfood exposures. Handling of petfood or raw meat petfood may be included as additional information in free text fields. The EpiSurv database was searched between 2008 and 2022 for cases notified for the diseases of interest and that had indicated *'handling of petfood'* and/or '*handling of raw meat petfood'* (Table 9). As it is unknown how many cases were specifically asked the questions relating to handling of petfood, an accurate percentage of those with this risk factor could not be calculated. Proportions were calculated using total notified cases which resulted in less than 1% of cases having reported handling raw meat petfood (Table 9).

The current standard EpiSurv case report form for enteric diseases does not have a specific question for household pet contact. However, the form does have a question specific to contact with farm animals and sick animals. If a household pet was considered a potential source of the human illness (i.e., the pet was symptomatic and ill), then this may also be entered in the probable and confirmed source fields by the investigating officer. In the listeriosis case report form, contact with infected animals may also be recorded in the probable and confirmed source fields. The STEC case report form does have a specific question regarding contact with household pets. Using the same EpiSurv data as outlined above, it was observed that annually 84 – 92% of STEC cases between 2008 and 2020 reported contact with a household pet prior to illness (Table 10). However, this question was only completed for around half of all reported STEC cases.

3.3.2 International context

An English-language online survey examined owner-reported frequency of pathogen transmission to humans living in or in contact with households feeding their pets raw, minimally processed (MP) diets (Cammack et al. 2021). No laboratory confirmed cases of pathogen transmission or infection were reported amongst 5,611 responses from 62 countries (93.2% of which were in US, UK, Canada, and Australia) with 77% of households

[20] EpiSurv collates notifiable disease information on a real time basis from the public health services in New Zealand. ESR operates EpiSurv on behalf of New Zealand Ministry of Health.

Table 9: Number of notified cases that indicated exposure to petfood/raw petfood in New Zealand between 2008 and 2022 [1,2]

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total (%)[3]
Campylobacteriosis																
Handled petfood	1	0	1	4	9	13	12	11	15	8	3	6	6	8	14	111 (0.11%)
Specified handling petfood raw	1	0	1	3	7	10	8	10	14	8	3	6	3	6	12	92 (0.09%)
Total cases reported	**6692**	**7177**	**7346**	**6686**	**7016**	**6837**	**6782**	**6218**	**7457**	**6482**	**6957**	**6203**	**5292**	**5727**	**5879**	**98751**
Salmonellosis																
Handled petfood	1	1	**0**	**0**	3	**0**	1	1	**0**	3	1	**0**	1	4	1	17 (0.1%)
Specified handling petfood raw	1	1	**0**	**0**	2	**0**	**0**	1	**0**	2	1	**0**	**0**	2	**0**	10 (0.06%)
Total cases reported	**1337**	**1128**	**1146**	**1055**	**1081**	**1143**	**955**	**1051**	**1091**	**1127**	**1100**	**1190**	**710**	**714**	**750**	**15578**
Listeriosis																
Handled petfood	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Specified handling petfood raw	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total cases reported	**27**	**28**	**23**	**26**	**25**	**19**	**25**	**26**	**36**	**21**	**31**	**33**	**36**	**33**	**39**	**428**
Yersiniosis																
Handled petfood	1	**0**	**0**	**0**	**0**	2	1	**0**	1	1	**0**	**0**	**0**	3	1	10 (0.08%)
Specified handling petfood raw	**0**	**0**	**0**	**0**	**0**	1	1	**0**	**0**	**0**	**0**	**0**	**0**	3	1	6 (0.05%)
Total cases reported	**508**	**430**	**406**	**513**	**514**	**483**	**680**	**634**	**858**	**917**	**1201**	**1185**	**1260**	**1410**	**1294**	**12293**
STEC illness																
Handled petfood	**0**	**0**	**0**	**0**	**0**	1	**0**	**0**	**0**	2	2	1	3	**0**	5	14 (0.19%)
Specified handling petfood raw	**0**	**0**	**0**	**0**	**0**	1	**0**	**0**	**0**	2	2	1	2	**0**	4	12 (0.17%)
Total cases reported	**122**	**143**	**138**	**153**	**147**	**205**	**187**	**330**	**417**	**547**	**924**	**1103**	**845**	**911**	**1022**	**7194**

Abbreviations: Shiga toxin-producing *E. coli* (STEC).

Notes: [1]The EpiSurv database was searched on 17 March 2023 for campylobacteriosis and 14 April 2023 for remaining notified diseases. As there are no specific questions relating to petfood exposures, case reports between 2008 - 2022 were searched for any text indications for cases that handled petfood and specifically handled petfood raw.

[2]The total number of cases that provided responses to the public health unit questionnaire is unknown, but it is likely to be low. It is currently not possible to provide a true proportion or rate for the exposure of raw meat petfood.

[3] Percentage of cases indicating handling of petfood or specifically handled petfood raw amongst all notified cases for that disease.

Table 10: Shiga toxin-producing *Escherichia coli* human cases who report contact with household pets, 2008 and 2022.

Contact with household pets	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
No	6	7	10	6	12	12	13	20	15	35	59	81	55	45	49
Yes	58	53	61	70	79	81	75	106	158	251	383	473	338	346	406
Not answered or unknown	58	83	67	77	56	112	99	204	244	261	482	549	452	520	567
Total STEC cases	122	143	138	153	147	205	187	330	417	547	924	1103	845	911	1022
Total answered	64	60	71	76	91	93	88	126	173	286	442	554	393	391	455
% Answered	52.5	42.0	51.4	49.7	61.9	45.4	47.1	38.2	41.5	52.3	47.8	50.2	46.5	42.9	44.5
% Pet contact[1]	**90.6**	**88.3**	**85.9**	**92.1**	**86.8**	**87.1**	**85.2**	**84.1**	**91.3**	**87.8**	**86.7**	**85.4**	**86.0**	**88.5**	**89.2**

Abbreviation: Shiga toxin-producing *E. coli* (STEC).
Notes: [1]Percentage refers to the number of cases that answered "yes" out of the total number of cases for which this information was known.

reporting feeding only MP diets to dogs and/or cats. However, the lack of confirmed laboratory reporting may mean that potential pathogen-related illness could be going undetected. In the case of gastrointestinal-related symptoms in humans or pets, it was observed that laboratory testing to determine presence of pathogens is not a standard first-line practice, which complicates identification of pathogen cases related to all diet types. Potential cases of transmission from raw petfood were identified from a total of 31 households (0.55%, 95% CI 0.38-0.79). The most frequently reported pathogens were *Salmonella* (n = 11, 0.2%), *Campylobacter* (n = 6, 0.1%) and *E. coli* (n = 4, 0.1%). Adults aged between 18 - 65 (n = 29, 78.4% of cases) were reported to be the most common age group amongst the cases.

A cross-sectional study used a multi-language internet-based survey to evaluate the impact of raw petfood on human health from the owner's experience (Anturaniemi et al. 2019). The study states that 0.2% (n = 39) of 16,475 households from 81 countries, reported a "confirmed transmission of a pathogen", including *Salmonella*, *Campylobacter*, *Yersinia. E. coli* and *Toxoplasma*, from raw petfood to humans (including immunocompromised persons), meaning that the pathogen was confirmed from a human sample by a laboratory. Caution must be taken when interpreting the results of this study, as there was no further detail on the microbial species that were "laboratory verified" as pathogens. The study also reported three households where the same pathogen (*E. coli*) was confirmed for both petfood and the sick human. However, it was observed that the questionnaire used for the survey was ambiguous and did not clearly ask which or what samples were "laboratory verified". The products implicated in the study included a commercial raw product, and a product purchased from an abattoir. Two of these households also had pets that were presenting with clinical symptoms as well. The study also reported a positive association with the occurrence of infections when children (2 - 6 years old) were in the household. However, it was hypothesised that pathogens may have been spread into the household with children from the day care centre or outside and transmitted to family adults without causing symptoms in the children (Anturaniemi et al. 2019).

It is likely that most raw petfood-associated human cases will be sporadic, and thus not investigated further for a cause, with under-recognition and under-reporting also contributing to a lack of data (Wales and Davies 2021). Transmission is likely dependent upon hygiene and food safety measures as well (Cammack et al. 2021).

3.4 RISK FACTORS ASSOCIATED WITH OTHER TRANSMISSION ROUTES

3.4.1 Companion animal illness associated with the consumption of raw meat petfood

New Zealand

In New Zealand, there are no published reports of companion animal foodborne illness of microbial hazards of interest attributed to commercial or any other raw meat petfood.

Most veterinarians when presented with an ill companion animal case will ask the owner about potential risk factors including pet's food and water sources. There are various examples of case histories observed by Lisa Hulme-Moir at Gribbles Veterinary Ltd that indicate a temporal or anecdotal link to feeding of raw meat petfood, however there is no routine funding for further investigation of these cases and source attribution is rarely performed. Veterinarians at this point would only provide advice to pet owners about the risk of raw meat feeding without any additional follow-up (Lisa Hulme-Moir, Gribbles Veterinary Ltd. Personal communication, 28 March 2023).

International context

The following reports were identified internationally, albeit two reports indicated home-prepared raw meat-based diets (i.e., not specially linked to commercial products):

- Salmonellosis diagnosed in two cats residing in the same household and fed home-prepared, raw meat-based diets. *Salmonella* was isolated from cats and samples of raw beef used in the feed. *Salmonella* Newport was identified from one cat and from the diet it had been fed. No further typing was performed on the isolates (Stiver et al. 2003).
- Two suspected cases of salmonellosis in cats within the same household fed with commercial frozen poultry raw meat-based diet. *Salmonella* was detected by polymerase chain reaction (PCR) in the animal faeces and *Salmonella* Typhimurium was isolated from a sample of poultry raw meat petfood provided by the owner. No further typing of isolates was reported (Giacometti et al. 2017).
- Diarrhoeal disease and death amongst puppies in a greyhound breeding facility prompted an investigation by the breeder. *Salmonella* Newport was isolated from multiple samples including dogs, raw meat food provided to the dogs (two brands of commercial raw frozen beef mixed with kibble) and the breeding facility environment. Multiple clones as determined by pulsed-field gel electrophoresis (PFGE) were identified as widespread within the environment samples. It was suspected that at least some of the *Salmonella* strains recovered from the premises were introduced via the raw meat being fed (Morley et al. 2006).

A 2019 report from the US also described the investigation of salmonellosis cases that involved cat and dog breeders, each with pet illness associated with raw petfood (Jones et al. 2019). The US Federal and Drug Administration (US FDA) received consumer complaints from these cases which prompted further investigation including testing of left-over raw petfood products and clinical samples (from dog's faeces or intestinal contents) and isolates were sequenced. Findings included:

- First case investigation involved a breeder of 11 cats and two cat foods. An unknown number of cats had diarrhoea. *Salmonella* Reading was isolated from a store-bought commercial raw turkey product and genetically clustered with an isolate from one of the asymptomatic cats and a historical ground turkey isolate.
- Second case investigation involved two households breeding dogs or cats, feeding raw petfood from the same manufacturer. One household had a puppy that died from septic bacterial enterocolitis and a culture of *Salmonella* Anatum was obtained. The second household had two kittens that died but no cultures were obtained. Three different *Salmonella* serotypes were isolated from the implicated raw petfood. The *Salmonella* Anatum from the puppy genetically clustered with an isolate obtained from the raw petfood, including isolates from the raw petfood obtained from the other household. The cause of the illness in the second household was therefore very likely a consequence of ingesting the raw petfood. *E. coli* obtained from the puppy and from raw petfood were not genetically related.

As highlighted in this case study, *Salmonella* was isolated from asymptomatic animals within the same household as the ill animals. Asymptomatic carriage of *Salmonella* and other foodborne pathogens in companion animals is commonly reported in the literature (Section 3.4) (Finley et al. 2007, Lambertini et al. 2016). The duration of *Salmonella* colonisation in dogs is unclear; one study indicated that asymptomatic shedding can occur for up to one week following ingestion of contaminated food (Finley et al. 2007). Other studies report that *Salmonella* can be shed in a dog's faeces for ≥6 weeks; continuously for the first week and then intermittently (Morse et al. 1976, Sanchez et al. 2002).

Outbreak investigations demonstrated the utility of sampling and testing multiple animals, both diarrhoeic and non-diarrhoeic, that eat a suspected diet or live within the same household environment (for example, cats sharing a litter box) to increase the likelihood of isolating a foodborne pathogen (Jones et al. 2019). The use of WGS to pair animal clinical and animal food isolates to identify animal foodborne illness outbreak is increasingly being reported (Jones et al. 2019). A recent small study from the UK, reported the WGS of *Salmonella* isolated from dried pet treats were also observed to cluster with human clinical cases in the UK, although epidemiological investigations were not performed to confirm the exposure (Morgan et al. 2023).

In the US, the FDA's Veterinary Laboratory Investigation and Response Network (Vet-LIRN) involves the Centre for Veterinary Medicine and veterinary diagnostic laboratories that respond to animal food issues and perform non-regulatory testing. Pet owners with sick animals that suspect a food or drug can submit a complaint to FDA online. The complaints are assessed and monitored for similar complaints and followed up. Vet-LIRN assesses animal medical records and conducts owner interviews, tests samples from animals and direct potential food- (or drug) related concerns to FDA for further investigation. In addition, the Vet-LIRN network also collaborates in an antimicrobial resistance monitoring program which involves testing sequencing and antimicrobial susceptibility of clinically relevant pathogens including *Salmonella* and *E. coli* (Ceric et al. 2019). This network was effective in identifying petfood attributed to both animal and human disease outbreaks, including strains with AMR.[21,22]

Overall, veterinary diagnostic laboratories can play a significant role in public health by conducting WGS and genomic analysis of paired animal clinical and animal food isolates to identify animal foodborne illness outbreaks (Jones et al. 2019).

3.4.2 Companion animal carriage and shedding of microbiological hazards associated with consumption of raw meat petfood

There are several international studies that have reported the association of feeding companion animal raw meat-based diets and prevalence of microbial pathogens shed by these animals (Table 11). Unfortunately, many of the studies focus on general raw meat-based diets, often home-made or diets that include some form of raw meat, often in comparison with dogs consuming commercial dry petfood.

Three studies were identified where commercial raw meat feed was specified:

- A study from Canada reported that dogs (n = 9) asymptomatically shed *Salmonella* within 1 - 7 days of consuming a *Salmonella*-contaminated commercial raw meat petfood, while dogs fed on a *Salmonella*-free raw meat petfood did not shed *Salmonella*. Those dogs shedding *Salmonella* were also found to shed serotypes that were present in the raw meat petfood. No further typing was reported and the number of dogs for each treatment group was small (n = 9 for each group) (Finley et al. 2007).
- A study from Finland tested faecal samples from dogs (n = 29) that were either fed commercial or homemade raw meat petfood and compared the shedding of *Campylobacter, Salmonella* and *Y. enterocolitica* from these dogs that were not fed raw meat (dry pellets). Results did not separate dogs fed commercial or homemade raw petfood. Although more dogs fed a raw-meat diet shed *Campylobacter* (16; 55%) compared with dogs that were fed dry pellets, this difference was not significant (p = 0.158). Of the dogs fed raw meat, two (7%) shed *Salmonella* and one (3%) shed *Y. enterocolitica.* Dogs fed the dry pellets did not shed these pathogens.
- A study from Chile tested raw meat-based diets, of which 31 commercial raw meat samples were either purchased or obtained from households where dogs were recruited for rectal swab testing. *Salmonella, C. jejuni* or *L. monocytogenes* were isolated from 33.3% (11 of 33) faecal samples from dogs fed a raw meat-based diet. Using PFGE, genetic similarities were observed between *Salmonella* isolates from faecal samples and raw meat petfood, but it was unclear as to whether these isolates were from commercial or homemade raw meat diets (eight commercial samples were positive for *Salmonella* compared with two for homemade samples). Poultry meat was the common ingredient in *Salmonella*-positive raw-meat petfood samples (Solís et al. 2022). A number of studies have reported that *Salmonella* serotypes shed by raw meat-fed dogs correlate with those isolated from their petfood and these isolates include serotypes associated with human disease (Joffe and Schlesinger 2002, Morley et al. 2006, Finley et al. 2008).

[21] https://www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-investigates-contaminated-pig-ear-pet-treats-connected-human-salmonella-infections (Accessed 17 March 2023)
[22] https://www.fda.gov/animal-veterinary/science-research/how-fdas-center-veterinary-medicine-improved-human-healthcare-during-outbreak-linked-puppies (Accessed 17 March 2023)

Table 11: Selected reported studies of enteric pathogens in companion cases linked to raw meat petfood

Year	Country	Pathogen	Sampling[1]	Key findings	Reference
2012-2013	NZ	*Campylobacter, Salmonella*	Recruited 50 working farm dogs that were fed home-killed raw meat at least once a fortnight. Faecal samples tested from each dog once. Raw meat feed from each owner also tested.	31 dogs (62%) and 3 (6%) raw meat feed samples were PCR-positive for *Campylobacter.* *C. upsaliensis* and *C. jejuni* most isolated. No *Salmonella* isolated from dog faeces or raw meat samples.	(Bojanić et al. 2019, Bojanić et al. 2022)
2005-2006	Canada	*Salmonella*	138 dogs in 84 households (sampling faeces for five consecutive days).	32 (23%) dogs had at least one faecal sample positive for *Salmonella*. 21 (25%) households had at least one dog shedding *Salmonella*. Predominant serotypes in order: Typhimurium > Kentucky > Brandenburg > Heidelberg. Statistical risk factors associated with *Salmonella*: - Contact with livestock, - Receiving probiotics in the previous 30 days, - Feeding a commercial or homemade raw food diet, - Feeding raw meat and eggs, - Feeding a homemade cooked diet, - Having more than one dog in the house.	(Leonard et al. 2011)
2005-2006	Canada	*Salmonella,* ESCR *E. coli*	200 healthy 'therapy dogs' (faecal sampling for each dog every 2 months for 1 year).	40 (20%) dogs were fed raw meat at some point during the study. Incidence rate of *Salmonella* shedding in the raw meat-fed dogs was 0.61 cases/dog per year, vs. 0.08 cases/dog per year for non-raw meat-fed dogs. *S.* Typhimurium, *S.* Heidelberg and *S.* Kentucky more common among dogs consumed raw meat vs. non-raw meat diets. ESCR *E. coli* shedding significantly associated with raw meat consumption (odds ratio 17.2; 95% CI 9.4-32.3).	(Lefebvre et al. 2008)
Not stated	Canada	*Salmonella*	10 dogs fed homemade raw meat diet and 10 dogs fed commercial dry dog food. Faeces and food were sampled.	3 dogs fed raw meat diet shed *Salmonella* compared with 0 dogs fed a commercial diet. *Salmonella* Schwarzengrund and *Salmonella* Braenderup isolated from dog faeces and raw meat foods tested.	(Joffe and Schlesinger 2002)
Not stated	Canada	*Salmonella*	16 dogs fed *Salmonella*-contaminated **commercial raw food diet** and 12 dogs fed *Salmonella*-free commercial raw food diet	7 dogs on *Salmonella*-contaminated raw food shed *Salmonella* 1-7 days asymptomatically after consumption. No dogs fed *Salmonella*-free raw diet shed *Salmonella*. Same *Salmonella* serotypes shed in dogs were present in the raw food.	(Finley et al. 2007)

Year	Country	Pathogen	Sampling	Key findings	Reference
Not stated	Finland	*Campylobacter*	36 dogs from 30 households. 15 dogs fed raw feed consisting of meat, bones, organs from pork, chicken, lamb and/or beef, turkey and salmon. 15 dogs fed commercial dry pellet food. 4 - 5 months feeding. Faecal samples tested before and after feeding period.	No statistical difference found between feeding strategies and *Campylobacter* shedding. *C. upsaliensis* recovered most frequently in dogs. Two *C. jejuni* isolates obtained from raw-fed dogs after dietary regimen and were same genotype, indicating a common infection source.	(Olkkola et al. 2015)
2013-2014	Finland	*Salmonella, Campylobacter, Y. enterocolitica*	50 faecal samples from 29 dogs fed **raw meat (commercial** or homemade) and 21 not fed raw meat. 75 faecal samples collected from two cats in same household across 8 - 12-month period. Both cats fed raw meat diet and are indoor only.	Raw meat fed dogs: *Campylobacter* detected (PCR) from 16 dogs (55%). Isolated from 20 dogs – mostly *C. upsaliensis. C. jejuni* from two dogs. *Salmonella* detected (PCR) 2 dogs (7%). One detection (PCR) of *Salmonella* and *Y. enterocolitica* (3%). Dry pellet fed dogs: *Campylobacter* detected from 7 dogs (33%) *Salmonella* and *Y. enterocolitica* not isolated. All but one faecal sample from cats PCR-positive for *Campylobacter*. *C. helvieticus* isolated from both cats. *Y. enterocolitica* bioserotype 4, O:3 isolated from both cats. No *Salmonella* isolated from cats. Link to raw meat diet unclear.	(Fredriksson-Ahomaa et al. 2017)
Not stated	Sweden	*Salmonella, Campylobacter,* ESBL-*E. coli*	25 dogs fed raw meat diet and 25 dogs fed dry kibble. Faecal samples tested (once per dog).	Raw meat-fed dogs: *Campylobacter* isolated from 12 dogs (48%). *Salmonella* Typhimurium isolated from 1 dog (4%). ESBL-producing *E. coli* from 13 dogs (52%). Dry kibble-fed dogs: *Campylobacter* and ESBL-producing *E. coli* isolated from 1 dog each (4%). *Salmonella* not isolated. *C. jejuni* identified from faeces of one dog fed raw meat. Remaining isolates from dogs were *C. upsaliensis* or *C. helveticus*. Significant difference in the incidence of *Campylobacter* in faeces from dogs fed raw meat diet compared with dry kibble diet.	(Runesvärd et al. 2020)
2004-2006	US	*Campylobacter, Salmonella*	Recruitment of dogs with either a raw meat diet (n = 42) or non-raw meat diet (n = 49). Faecal samples, feed samples tested and vacuum cleaner samples from the household (once per dog).	*C. jejuni* isolate from 1 dog fed raw-meat diet (3%). *Salmonella enterica* (various serotypes) isolated from 2/40 raw meat feeds, 6 dogs fed raw meat diet (14%), 4/38 (11%) and 2/44 (5%) of vacuum cleaner samples from raw meat-fed and non-raw meat-fed dogs' households, respectively.	(Lenz et al. 2009)

Year	Country	Pathogen	Sampling	Key findings	Reference
2017-2018	Brazil	*Salmonella*	Recruitment of dogs with either a raw meat diet (n = 46) or commercial dry feed diet (n = 192). Faecal samples tested (once per dog).	Raw meat-fed dogs*: Salmonella* isolated from 7 dogs (15%). Commercial dry-fed dogs: *Salmonella* isolated from 1 dog (0.5%). Serovars Typhimurium, Saintpaul, Schwarzengrund, Panama and Heidelberg identified. Dogs fed raw meat diets were 30 times more likely to be *Salmonella*-positive compared with dogs fed a commercial dry feed diet.	(Viegas et al. 2020)
Not stated	Chile	*Salmonella, C. jejuni, L. monocytogenes*	66 dog food samples, **31 commercial raw meat**, 11 homemade raw meat and 24 extruded diets. Obtained samples from either recruitments or purchased. Recruitment of healthy dogs, 33 raw meat fed diets and 22 extruded. Rectal swabs tested (once per dog).	*Salmonella spp., C. jejuni* and *L. monocytogenes* from 33% (11/33) faecal samples from dogs fed raw meat-based diets. Genetic analysis using pulsed-field gel electrophoresis found genetically similar *Salmonella* isolates from dogs and raw meat petfood.	(Solís et al. 2022)
2015	UK	*Salmonella, E. coli*	Recruitment of dogs with either raw (n= 114) or non-raw (n = 76) diets. Faecal samples tested.	*Salmonella* detected in 8 raw meat-fed dogs only. Antimicrobial, multi-drug resistant *E. coli* detected in raw fed (54 and 25%, respectively) compared with non-raw fed (17 and 4%, respectively) dogs.	(Groat et al. 2022)
2014-2019	Brazil	*E. coli* - AMR	Recruitment of dogs with either a raw-meat (n=38) or commercial dry (n=54) diets. Faecal samples tested.	Dogs fed raw meat diets more frequently shed multi-drug resistant *E. coli*.	(Ramos et al. 2022)

Abbreviations: New Zealand (NZ), Extended-spectrum cephalosporinase resistant (ESCR) *E. coli*, Extended-spectrum beta-lactamases (ESBL)-producing *E. coli*. Antimicrobial resistance AMR, United States of America (US).
Notes: [1] Those in **bold** include commercial raw meat petfood in the study.

In addition, raw meat-based diets have been identified as a risk factor for the shedding of bacteria with AMR in pets (Table 8) (Lefebvre et al. 2008, Baede et al. 2015, Schmidt et al. 2015, Baede et al. 2017, Wedley et al. 2017, Nüesch-Inderbinen et al. 2019, Groat et al. 2022). One study reported the shedding of ESBL *E. coli*, *Campylobacter* or *Salmonella* from dogs (13 out of 25 dogs) when they were fed raw-meat based diets, compare to one dog that shed ESBL *E. coli* that was fed dry kibble (Runesvärd et al. 2020). A cohort study in household cats identified 78% (14 out of 18) of raw meat cat food samples were positive for ESBL-producing Enterobacteriaceae, while all non-raw diets (n = 20) were negative. A strong association between feeding raw-meat petfood and shedding of ESBL-producing Enterobacteriaceae in household cats was observed (Baede et al. 2017). The consumption of a raw-meat diet by dogs was found to increase the chance of *E. coli* transmission between the owners and their dogs (Naziri et al. 2016, Wedley et al. 2017, Ramos et al. 2022).

Overall, whether commercial or homemade raw meat petfood is involved, many studies provide compelling evidence that dogs and cats fed on these diets can shed pathogens, particularly *Salmonella* and *Campylobacter*, without any associated clinical signs. Feeding of raw meat petfood presents an increased risk of these pathogens being shed by these animals, compared with dry feed. Companion animals that are either symptomatically or asymptomatically shedding pathogens presents a source of environmental contamination that could potentially lead to human or animal disease (Finley et al. 2007, Lunn 2011).

3.4.3 Surveillance of companion animal illness associated with microbial hazards of interest

MPI has a target programme that focuses on animal health surveillance in NZ.[23] Data for animal illness diagnoses for pathogens of concern are collated from veterinary diagnostics laboratories (Gribbles Veterinary Laboratory Ltd, SVS or IDEXX, on behalf of MPI) and monitored routinely for emerging disease risks.

The Animal Health surveillance programme is a passive surveillance programme. Consequently, it should be recognised that data from this programme will be subject to several biases that are known to impact passive surveillance data. For example, typically, a veterinarian will send between one and five samples from a group of sick animals on a farm, often from the worst affected animals, and the veterinary diagnostic laboratories will subsequently refer one sample per case (or case farm) to ESR for serotyping. Consequently, a serotype result may represent an individual animal or multiple animals (upwards of hundreds of cows in a group). The more severe the illness or outbreak on a farm, the more likely that a veterinarian will be called, and animals tested. It is likely mild infections that are not recognised as potentially being salmonellosis may be missed and not tested, especially if the animals are without any signs of diarrhoea (Lisa Hulme-Moir, Gribbles Veterinary Laboratory Ltd. Personal communication, 28 March 2023).

Table 12 summarises the numbers of *Salmonella* serotypes reported as a part of the MPI surveillance programme for 2021 (Biosecurity New Zealand Ministry for Primary Industries 2022). These numbers also include companion animals, such as dogs and cats. For companion animals, pet owners may choose to test their pets that are ill.

[23] https://www.mpi.govt.nz/biosecurity/how-to-find-report-and-prevent-pests-and-diseases/surveillance-programmes/#:~:text=MPI's%20surveillance%20system%20brings%20together,or%20disease%2C%20in%20any%20environment (Accessed 12 April 2023)

Table 12: *Salmonella* serotypes isolated from animals as a part of MPI animal surveillance in 2021[1]

Salmonella serotype	Canine	Feline	Avian[2]	Bovine	Caprine	Equine	Other	Ovine	Porcine
Agona	0	0	0	3	0	0	0	0	0
Amsterdam	0	0	0	2	0	0	0	0	0
Bere	0	0	0	1	0	0	0	0	0
Bovismorbificans	4	4	0	96	0	0	0	3	2
Brancaster	0	0	0	0	0	0	0	0	0
Brandenburg	15	0	0	40	1	0	0	22	0
Derby	1	0	0	0	0	0	0	0	0
Emek	1	0	0	0	0	0	0	0	0
enterica[3]	0	0	0	4	0	0	0	0	0
Enteritidis	3	5	0	1	1	0	0	1	0
Give	12	0	0	1	0	0	0	0	0
Hindmarsh	0	0	0	60	0	0	0	17	0
Infantis	1	0	0	1	0	0	0	0	0
Kentucky	0	0	0	1	0	0	0	0	0
Mbandaka	2	0	0	1	0	0	0	0	0
Mississippi	0	0	0	0	0	0	0	0	0
Rough	1	0	0	1	0	1	0	0	0
Saintpaul	1	0	0	0	0	0	0	0	0
Senftenberg	1	0	0	5	0	0	0	0	0
Stanley	1	0	0	0	0	0	0	0	0
Thompson	2	0	0	1	0	0	0	0	0
Typhimurium	23	16	12	192	2	15	0	4	1
Unspecified	6	2	0	9	0	7	0	0	0
Total	**74**	**27**	**12**	**419**	**4**	**23**	**2**	**47**	**3**

Notes:[1] Data extracted from (Biosecurity New Zealand Ministry for Primary Industries 2022). Excluding reptiles.
[2] Avian are birds that do not include poultry.
[3] It is unclear from the data whether these *Salmonella* enterica were isolates where a serotype was not identified.

An unpublished study by Lisa Hume-Moir (2022) from Gribbles Veterinary Laboratory analysed the *Salmonella* serotypes observed for dogs and cats diagnosed by Gribbles laboratories between 2011 and 2021 (Table 13). *Salmonella* Typhimurium was the most frequent serotype identified for dogs and cats in 2020, but *Salmonella* Bovismorbificans was also common in both dogs and cats. This observation was consistent with the overall national surveillance *Salmonella* isolations for companion animals reported in 2020, as a part of the MPI surveillance programme (Figure 3). The study of Hume-Moir (2022) found that the majority of cases of *Salmonella* Bovismorbificans, *Salmonella* Brandenburg and *Salmonella* Give that occurred in cats and dogs resided in urban city centres such as Auckland (50%), Canterbury (15%), Waikato (12%) and Wellington (9%).

Table 13: Number of salmonellosis cases and their associated serotypes diagnosed for dogs and cats between 2011-2021 at Gribbles Laboratory[1]

Animal	*Salmonella* serotype	Number of cases/total cases for the animal species
Dogs	Typhimurium	65/177
	Brandenburg	35/177
	Bovismorbificans	22/177
	Give	13/177
	Saintpaul	8/177
	Infantis	7/177
	Enteritidis	7/177
	Other serotypes	20/177
Cats	Typhimurium	74/100
	Bovismorbificans	15/100
	Saintpaul	4/100
	Enteritdis	3/100
	Brandenburg	2/100
	Mbandaka	1/100
	Victoria	1/100

Notes:
[1]Extracted from (Hulme-Moir 2022).

The study of Hume-Moir (2022) observed over 50 breeds of dogs occurred amongst the salmonellosis cases in New Zealand between 2011 - 2022. Most illness submissions from dogs were of gastrointestinal disease with the exception of one abortion in a farm dog diagnosed with *Salmonella* Brandenburg and two cases of urinary tract infection (UTI). There were also notable differences between age groups of dogs with respect to other pathogens being detected as a part of full diarrhoea panel testing. For example, both *Giardia* and *Campylobacter* were less commonly detected in dogs older than one year of age (Hulme-Moir 2022).

In comparison, distinct differences were noted for cat breed distribution diagnosed with *Salmonella* Typhimurium compared with non-Typhimurium serotypes. Cats with *Salmonella* Typhimurium showed a breed distribution that approximated the general cat population with 58% of cases being domestic short, medium and long-haired cats, 34% pedigree cats and 8% with no breed recorded. However, 73% of non-Typhimurium cases were pedigree cats with only 23% occurring in domestic short haired cats.

Age distribution was also different between Typhimurium and non-Typhimurium cases, with non-Typhimurium cases tending to be younger and more frequently involving litters of kittens (19% of cases versus 1.5%), largely from breeding establishments. Cases in cats older than one year of age were also more frequently negative for all other pathogens within the

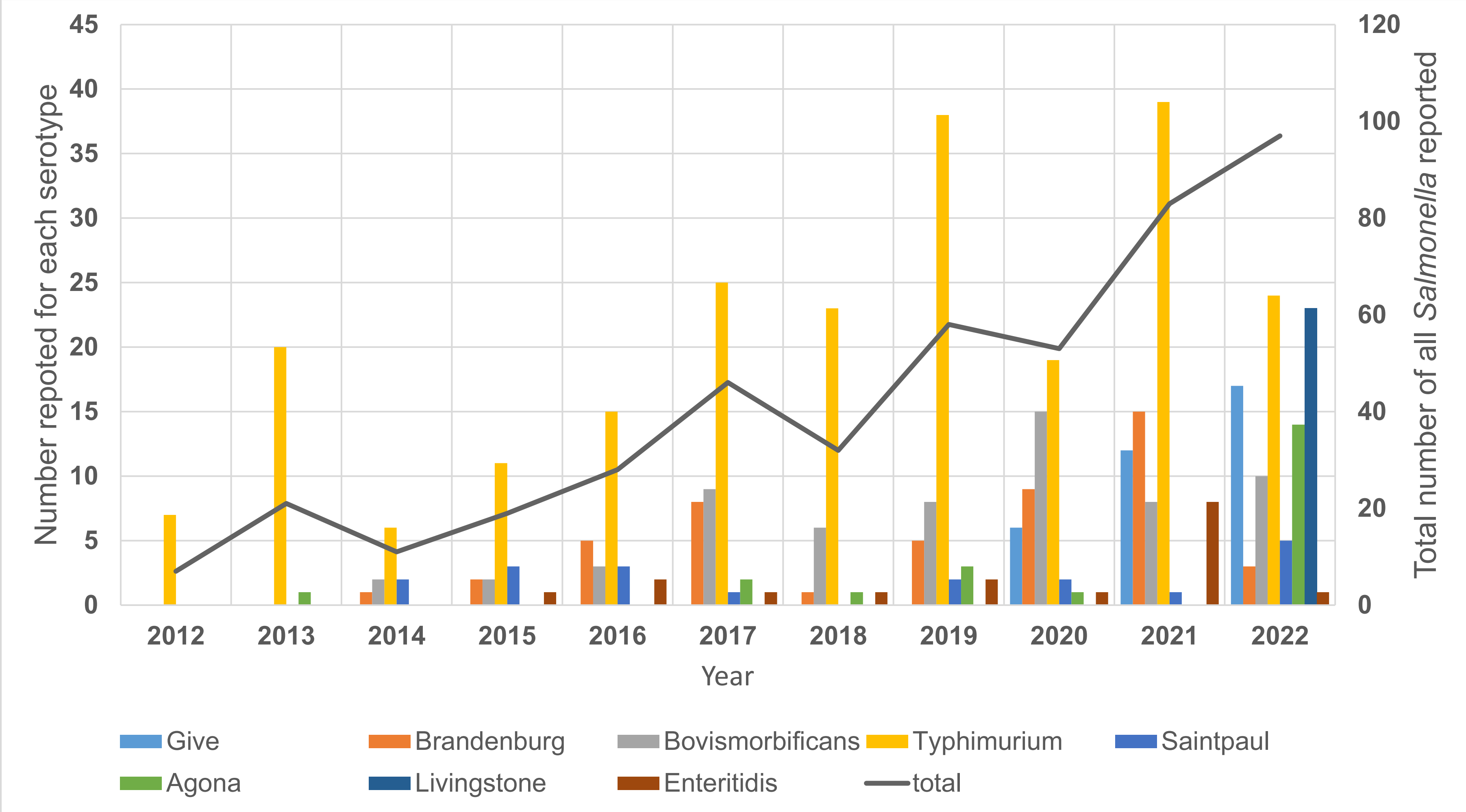

Figure 3: Overview of number of companion animal illness isolations of selected Salmonella serotypes reported under the Ministry of Primary Industries (MPI) surveillance programme between 2012 – 2022. Data provided by Jon Watts, MPI (31st May 2023)

diarrhoea panels (Hulme-Moir 2022). For cats, gastrointestinal disease was the most common presentation, with one case each of liver abscesses, endocarditis, osteomyelitis, septic arthritis and UTI (Hulme-Moir 2022).

According to the study of Hulme-Moir (2022), the surveillance data showed a significant increase in cases of salmonellosis in dairy cattle in New Zealand between 2011 and 2021. (**Figure 4**). In addition to the increased prevalence, there has also been a notable change in the serotypes causing disease with the emergence of several serotypes that previously had been uncommon, namely *Salmonella* Bovismorbificans, *Salmonella* Give and *Salmonella* Brandenburg (**Figure 4**)(Hulme-Moir 2022). Another New Zealand study that evaluated veterinary laboratory submissions from beef and pre-production dairy cattle between 2003 and 2016, highlighted *Salmonella* Typhimurium and *Salmonella* Brandenburg as the most common *Salmonella* serotypes identified in beef calves and adult cattle with diarrhoea or ill thrift (Lawrence et al. 2019).

The study of Hulme-Moir (2022) also observed that the geographical distribution of companion animal cases of salmonellosis was distinct to cases occurring in cattle. In particular, *Salmonella* Brandenburg and *Salmonella* Give had previously had a distinct geographical distribution in cattle. *Salmonella* Brandenburg emerged as a significant pathogen in sheep and subsequently cattle in the mid-1990's in the lower South Island (Clark et al. 2004). Despite being present in New Zealand for over 25 years, cases in cattle and sheep continue to remain largely restricted in the South Island with Brandenburg rarely reported in the North Island. *Salmonella* Give has recently emerged in cattle and was initially restricted to the Waikato region (Hulme-Moir 2022). In the last 12 months, *Salmonella* Give cases in cattle have started to occur in the wider area of the North Island (Lisa Hulme-Moir, Gribbles Veterinary Laboratories, Personal communication, 28 March 2023).

Within the 2011 – 2021 companion animals surveillance data, three dog cases involved outbreaks of SE in greyhound kennels and two outbreaks occurred in litters of puppies at breeding. These isolates were reported as PT11[24] (no WGS data available). Whether raw meat petfood was fed to these animal cases is unknown. As outlined in Section 3.4, studies internationally have observed a link between raw diets and illness associated within dog breeding establishments. Puppies and kittens fed contaminated raw petfood may be a health risk for other animals and people especially when those animals are sold or commercially transported (Connolly et al. 2014, Jones et al. 2019).

Selected animal SE isolates collected as a part of the MPI animal surveillance programme have been whole genome sequenced during the SE poultry-associated outbreak in 2021 (Ministry for Primary Industries 2021) and more recently when notified SE cases increased for both human and animal cases. Historically, SE from sick animals were all routinely phage-typed (PT) as PT9a which was revised to PT11 when the phage typing method was reviewed and extended in 2010. All SE PT11 included in the dataset for validating ESR's transition to WGS typing were observed to be ST183 using WGS (Jackie Wright, ESR, Personal communication, 28 April 2023). During the SE outbreak in 2021, one cow, dog and goat, two cats and rodents were identified to be positive for the SE outbreak strain. With the exception of the two cats, the remaining animals all had epidemiological links to identified SE-positive poultry farms (Ministry for Primary Industries 2021).

[24] https://www.esr.cri.nz/our-research/nga-kete/infectious-disease-intelligence/enteric-reference-testing/non-human-salmonella-isolates/ (Accessed 14 April 2023)

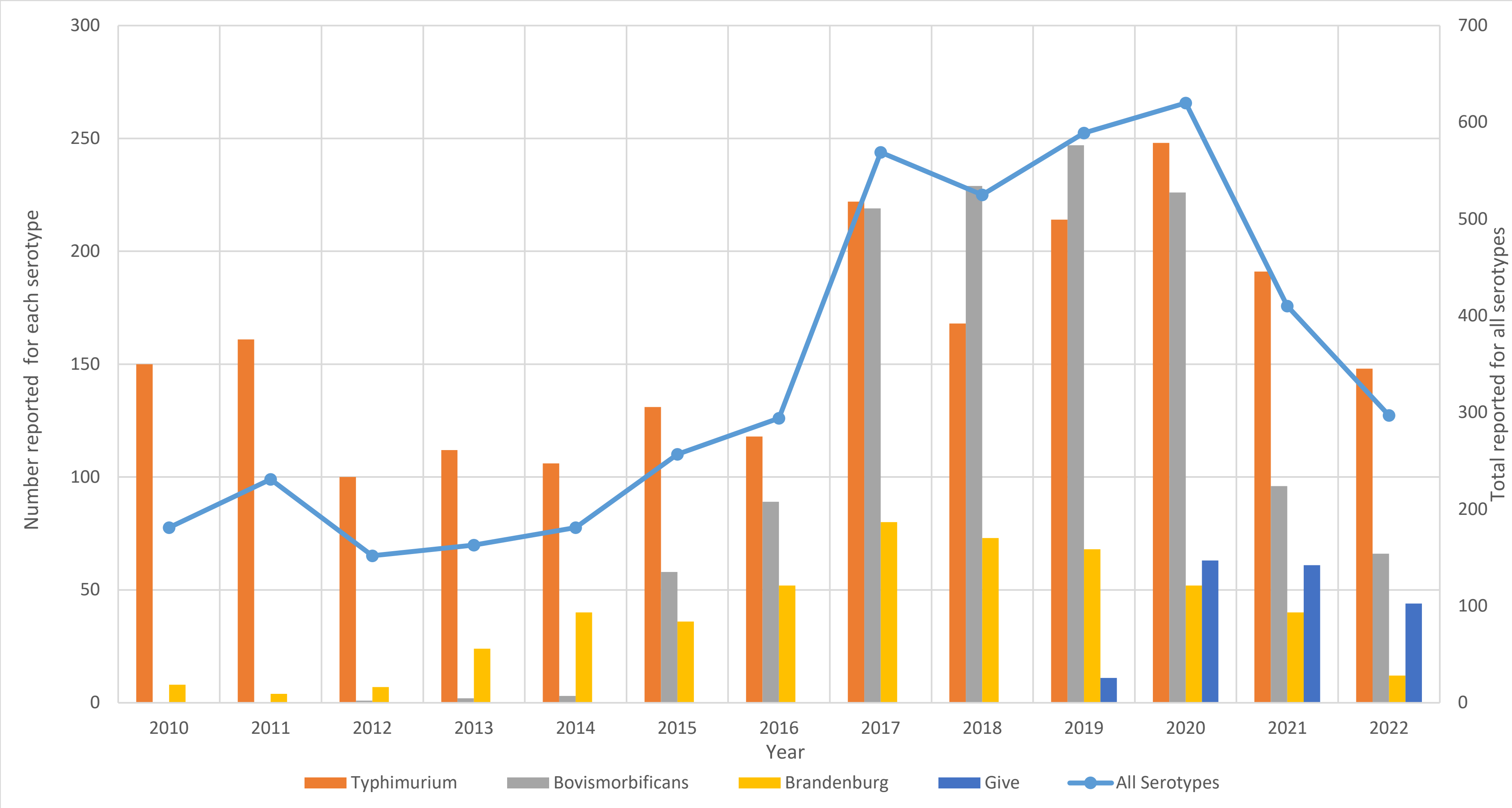

Figure 4: Overview of number of bovine animal illness isolations of selected Salmonella serotypes reported under the Ministry of Primary Industries (MPI) surveillance programme between 2010 – 2022. Data provided by Jon Watts, MPI (31st May 2023)

Overall, using data from 2011 – 2022, the study of Hulme-Moir (2022) observed that animal cases of salmonellosis occurring in urban locations were geographically remote to where

disease was occurring in production animal species. This has posed the question as to whether contaminated meat products consumed by companion animals may be a potential route of infection for these animals. Since this study, the MPI surveillance programme has observed an increase in *Salmonella* Livingstone and *Salmonella* Agona in companion animals in 2022 (Figure 3). The rate of increase for these serotypes was not observed within the reported bovine salmonellosis cases in 2022. It is unclear as to whether these serotypes are less pathogenic for bovine animals or whether there are unrecognised sources of infection that may contributing to this increase of these serotypes in companion animals.

Currently, serotyping is routinely performed for *Salmonella* isolates obtained as a part of the MPI surveillance programme, with sequencing only performed in selected circumstances, such as with the SE outbreak mentioned above. It is therefore unknown whether the *Salmonella* isolates from cattle and other animals including companion animals are genetically related.

As outlined in Section 3.4, *Salmonella* can also be asymptomatically shed by companion animals. However, the proportion of companion animals asymptomatically shedding *Salmonella* in New Zealand, and whether they are contributing to human disease, is currently unknown.

Campylobacter

Dogs and cats can present with sub-clinical *Campylobacter* infections with some developing mild-to-moderate enteritis (LeJeune and Hancock 2001, Weese 2011). Several studies have described the presence of various species of *Campylobacter*, including strains with AMR, from dogs and cats (see reviews by (Acke 2018, Iannino et al. 2019)). One study reported that the levels of individual *Campylobacter* species detected in dog faeces (using real-time PCR) was between 10^3 and 10^8 organisms per gram of faeces (Chaban et al. 2010). A systematic review and meta-analysis reported the mean prevalence of *Campylobacter* in household pets was 24.7% based on 34 studies and estimated numbers were 2.9 x 10^5 cfu/g (Pintar et al. 2015).

Young animals, animals from intensive housing backgrounds, and animals with concurrent disease are particularly predisposed to infection and the development of clinical signs of campylobacteriosis (Parsons et al. 2011, Iannino et al. 2019, Thépault et al. 2020, Iannino et al. 2022). Contact with dogs and cats is a recognised risk factor for human campylobacteriosis, thus people living or working in close contact with cats and dogs should be made aware of the risks associated with *Campylobacter* (and other pathogens) these animals can shed (Acke 2018).

In New Zealand, *Campylobacter* species have been reported to be frequently isolated from faecal samples collected from dogs and cats. Rectal swabs from 90 dogs and 110 cats undertaking elective procedures (for example, vaccination, neutering, health checks) were tested for *Campylobacter*. An overall *Campylobacter* spp. prevalence of 36% and 16% were reported from dogs and cats, respectively. The most common species identified were *C. jejuni*, *C. upsaliensis* and *C. helveticus* (Bojanić et al. 2017). In another New Zealand study, the faeco-prevalence of *C. jejuni* in dogs (n = 498) and cats (n = 82) was reported to be 5% and 7%, respectively (Mohan 2015).

Animal surveillance data from NZ shows that *Campylobacter* spp., including *C. jejuni, C. helveticus*/*C. upsaliensis* (these two species are not differentiated at the diagnostic veterinary laboratories) are commonly detected in companion animals presenting with gastrointestinal illness (data not shown). As *Campylobacter* can be carried by healthy companion animals, it can be difficult to ascertain the significance of the detection of *Campylobacter* in these ill companion animal cases (Lisa Hulme-Moir. Personal communication, 7 June 2023)

The study of Bojanić et al. (2017) used MLST to characterise the *C. jejuni* isolates from pets. In dogs, ST474 and ST45 were identified in three dogs each; and ST21, ST61, ST520 and ST4492 in one dog each. In cats, two ST3696 isolates and one ST48 isolate were detected. No further WGS was performed to establish whether these isolates had a close genetic relationship but these shared STs were common STs detected in both chicken and humans at the time of the study (Mullner et al. 2009, Bojanić et al. 2017).

Internationally, other studies have demonstrated overlaps with STs of *C. jejuni* and/or *C. coli* between pets and humans, suggesting a role of pets as a source of *Campylobacter* exposure for humans or vice versa (Mughini Gras et al. 2013, Lemos et al. 2021). When combined with a case-control study, it was found that dog owners, particularly those with puppies, were at a higher risk of infection with STs associated with pets than controls or non-dog owners (Mughini Gras et al. 2013). Common sources and directionality of transmission between pets and humans are unclear, but dog ownership significantly increased the risk for pet-associated *C. jejuni/coli* infection in humans, but not cat ownership (Mughini Gras et al. 2013).

C. upsaliensis is widely described as the predominant *Campylobacter* species from pets, especially from dogs, while some studies report *C. helveticus* as the most prevalent species in cats (Hald et al. 2004, Rossi et al. 2008, Mughini Gras et al. 2013, Thépault et al. 2020). Factors including the influence of season, sampling protocols and isolation methods may influence the variation observed between studies (Thépault et al. 2020).

STEC

Although not commonly reported, international studies indicate that dogs and cats can both serve as asymptomatic shedders in the epidemiology of a wide range of STEC serotypes (Beutin 1999, Hogg et al. 2009, Rumi et al. 2012). The epidemiological role of dogs and cats as a source for human infections in New Zealand is currently unknown.

Listeria monocytogenes

In New Zealand, *L. monocytogenes* can cause nervous signs in ruminants (Table 14), but is rarely observed to cause illness in dogs or cats (Pritchard et al. 2016, Elbert and Rissi 2021). One study cited a case report from Germany of an abortion caused by *L. monocytogenes* in a dog that consumed a raw food diet. However, the source of the infection was not confirmed (LeJeune and Hancock 2001). Two international studies reported that *L. monocytogenes* was infrequently isolated from dog (0.9 - 1.3%) and cat (0 - 0.4%) faecal samples (Iida et al. 1991, Weber et al. 1995).

Yersinia enterocolitica

In 2020, yersiniosis was diagnosed in cattle and farmed deer (Table 14). Yersiniosis in New Zealand, including in sick animals, was reviewed by Rivas et al. (2021c). Based on New Zealand national veterinary diagnostic data available in 2017, it was reported that animal yersiniosis was increasing (Rivas et al. 2021c). A small, unpublished NZ pilot study typed a selection of *Yersinia* isolated from sick animals by diagnostic veterinary laboratories between January and March 2018. Over 96% of strains were from cattle (90 out of 93) and were predominantly *Y. pseudotuberculosis* ST19, a type not frequently reported in human cases (Rivas et al. 2021c).

A study in New Zealand found that dogs can be sub-clinically infected with *Y. enterocolitica* (Fenwick 1997). Possible transmission of this pathogen between pets and people has been reported in the literature (Fenwick 1997, Fredriksson-Ahomaa et al. 2001).

Y. enterocolitica is frequently associated with pork, but can be detected in other meat products, including raw meat petfood (Morelli et al. 2020). A study in Finland identified *Y. enterocolitica* in 11% (10 out of 88) raw meat petfood samples, namely those containing pork, as well from one dog (out of 29) and one cat (out of 2) fed with those diets (Fredriksson-Ahomaa et al. 2001).

Table 14: Number of animal cases and diagnoses of microbial pathogens of interest in 2021 in New Zealand [1,2]

Animal	Organism	Condition	Number of cases/total sick animals' cases for the species.
Cattle	*Yersinia* spp.	Ill thrift/diarrhoea	502/20,016
	Listeria monocytogenes	Nervous signs	2/20,016
Sheep	*Campylobacter* spp. (not *fetus* ssp. *fetus*)	Abortion	2/1,728
	Toxoplasma gondii	Abortion	24/1,728
	Salmonella Brandenburg	Abortion	21/1,728
	Listeria monocytogenes	Nervous signs	5/1,728
Farmed deer	*Yersinia* spp.	Ill thrift/diarrhoea	10/111
Goats	*Listeria monocytogenes*	Nervous signs	0/573

Notes: [1] Only data for the microbial pathogens within the scope of this discussion document was extracted from (Biosecurity New Zealand Ministry for Primary Industries 2022). The original table provided a selection of presenting syndromes in some instances with examples of corresponding diagnoses.
[2] Pigs do not have specific organisms listed within the conditions. Horses did not have any cases of relevant pathogens of interest.

Toxoplasma gondii

Toxoplasmosis causes abortions in livestock and was diagnosed in 12 (1.1%) of 1,526 sheep cases submitted in New Zealand veterinary investigations in 2020 (Table 14Table 14).

There is an established zoonotic risk of *T. gondii* from infected cats. International studies have reported an increased *Toxoplasma* seroprevalence and oocyst shedding from cats fed a raw-diet or homemade diets compared with those that are not (Lopes et al. 2008, Coelho et al. 2011, Freeman et al. 2013, Davies et al. 2019). Domestic cats contribute to the greatest source of environmental disease burden and may shed substantial numbers of oocysts, even after consuming only one cyst from infected meat (Álvarez García et al. 2021). As humans do not typically consume raw meat petfood, the possible acquisition of *T. gondii* from these products is via either direct contact with an infected cat or ingestion of sporulated oocysts from contaminated environments (Ahmed et al. 2021).

Although dogs may become infected with *T. gondii*, they are not definitive hosts and therefore do no pass infective oocysts into the environment (LeJeune and Hancock 2001).

Antimicrobial resistant bacteria

Studies from New Zealand have reported antimicrobial susceptibility of bacteria cultured from samples submitted to commercial veterinary diagnostic laboratories from beef and pre-production dairy cattle and sheep between 2013- 2016 (Lawrence et al. 2019, Riley et al. 2021). Overall, both studies had no or limited antimicrobial susceptibility data for *Salmonella* spp., *Campylobacter*, *Listeria* spp. or *Yersinia* spp. For beef and dairy cattle, 22.7% (57 out of 251) of isolates tested for antimicrobial susceptibility had multi-drug resistance which was most common in *Enterococcus* spp. (12/17; 70.6%) and *E. coli* (13/30; 43.3%). For sheep, of the 117 isolates tested, 24 (20.5%) were multi-drug resistant which was most frequently observed for *Enterococcus* spp., *Bacillus* spp., and *Proteus mirabilis* (Riley et al. 2021).

A survey to assess AMR of *Campylobacter, Salmonella, E. coli* and *Enterococci* isolated from fresh dressed carcasses of very young calves, pigs and broiler poultry in New Zealand, reported that resistance amongst isolates were usually less than that reported for human isolates of the same bacterial species in 2009 (Heffernan et al. 2011).

Historically, the rates of AMR have been low among *Campylobacter* isolates from both human and animal sources in New Zealand (Heffernan et al. 2011, Williamson et al. 2015, Ministry of Health and Ministry for Primary Industries 2017). In 2014, antimicrobial drug-resistant (to fluoroquinolones and tetracycline) *C. jejuni* ST6964 was identified in poultry from three supply companies in New Zealand and was a major cause of campylobacteriosis in humans in New Zealand (French et al. 2019). Cross-sectional studies of poultry and humans suggested that fluroquinolone resistance in *C. jejuni* had increased from <5% to 19% over one year (Williamson et al. 2015). To date, there has been no detection of *C. jejuni* ST6964 in companion animals in New Zealand and the role of pets in the transmission of this ST to humans is unknown.

3.5 RECALLS AND BORDER REJECTIONS

3.5.1 New Zealand

No petfood related recalls were identified within the MPI recalled food product lists 2015-2023.[25]

A search undertaken by MPI in February 2023 identified two petfood recalls under the Agricultural Compound and Veterinary Medicines (ACVM) Act,[26] since the establishment of

[25] https://www.mpi.govt.nz/food-safety-home/food-recalls-and-complaints/recalled-food-products/ (Accessed 30 January 2023)
[26] https://www.legislation.govt.nz/act/public/1997/0087/latest/whole.html (Accessed 23 March 2023)

the ACVM database in 2016, but both recalls were due to hazards not within the scope of this document (unacceptable mycotoxin and Vitamin D levels). International recalls are actively accessed through the Food Compliance surveillance process. However, no other recall records for any petfood were identified through this surveillance process.

3.5.2 International context

Australia

The Australian Failing Food Reports website[27] lists imported foods that were checked at the border and were classed as a 'failed food' because they failed an analytical test, contained non-permitted ingredients, or were a prohibited plant or fungus.

Australian imported food inspection does not specify any testing of imported petfood. It does for beef and beef products and poultry meat but does not provide detail on whether these products are intended for petfood. There were no imported 'raw meat petfood', 'petfood' or 'raw meat' reported as 'failed food' during the period of January 2020 to November 2022.

In Australia, there is no legal requirement to recall any petfood product. Recalls are voluntary for a producer. The FSANZ website[28] lists human food safety recalls and their power to order a food product recall where a serious public health and safety risk exists but is limited to food intended for human consumption (Standing Council on Primary Industries Pet Food Controls Working Groups 2012). A search of the FSANZ website confirmed no recalls associated with 'raw meat petfood', 'petfood' or 'meat' relevant to raw petfood.

A 'Petfood Adverse Event System of Tracking' (PetFAST) system is a voluntary joint initiative with the Australian Veterinary Association (AVA) and the Petfood Industry Association of Australia (PFIAA).[29] This is a reporting system that tracks all suspected adverse events, defined as events where unintended consequence, which may be mild, moderate or severe, may be linked to petfood, including raw food. All types of foods are tracked within the system which collects reports submitted by veterinarians across Australia. The system investigates trends and can recommend product withdrawals and recalls where necessary. PetFAST does not have the authority to issue recalls but can issue advisory notices and liaise with a manufacturer about issuing a recall. The system focuses on pet diagnoses only.

Canada

In 2019, 2018 and 2017, the Canadian Food Inspection Agency[30] made 67, 100 and 134 border rejections, respectively. None of these included petfood. A search of the Canadian recalls and safey alert website[31] identified four recall notices for a raw petfood which included:

[27] https://www.awe.gov.au/biosecurity-trade/import/goods/food/inspection-testing/failing-food-reports (Accessed 3 April 2023)
[28] https://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/default.aspx (Accessed 14 April 2023)
[29] https://pfiaa.com.au/petfast-a-pet-first-approach-to-food-safety/ (Accessed 1 February 2023)
[30] https://inspection.canada.ca/about-cfia/transparency/regulatory-transparency-and-openness/compliance-and-enforcement/refused-entry/eng/1324305448701/1324305531127 (Accessed 3 February 2023)
[31] https://recalls-rappels.canada.ca/en, (Accessed 3 February 2023)

- Raw frozen meat patties for dogs recalled due to *L. monocytogenes* contamination in 2022.[32]
- Raw meat petfood attributed to an oubreak of human cases of STEC O157:H7 in 2020 (Section 3.2.2).[33]
- Two recalls in 2018 from the same producer of raw meat petfood due to *L. monocytogenes* contamination.[34, 35]

European Union

A search of the European Union (EU) Rapid Alert System for Food and Feed (RASFF) searchable database[36] for the period 2020 to 2023 was performed using the search term 'raw' and filtered for relevant raw petfood entries (Appendix B). Table 15 outlines all entries stating raw petfood, of which ten of the entries were due to the presence or possible presence of *Salmonella*, and two were for Enterobacteriaceae.

United States of America

The US FDA database of border refusals (equivalent to border rejections) from 2014 to 2022 was interrogated[37] and the data was filtered for the presence of "pet", "pet dog food", "pet cat food" or "petfood" in the product description field. Entries that had "raw hide", "pet chews" or "pet treats" were excluded.

Of the refusal entries, only those labelled with the refusal charge of containing *Salmonella* (CHRG CODE 9) were deemed relevant for this discussion document. This resulted in a list of 49 distinct border refusals that are listed in Appendix C, Table 22. The database does not provide detailed information on the type of petfood product beyond the descriptions provided. Therefore, it was not possible to establish if any of these products were specifically a raw meat petfood product or intended to be used in the production of a raw meat petfood product (i.e., Meat [Mammalian muscle] pet dog food). However, this information may provide some context for the *Salmonella* risk of imported petfood identified during US border inspection.

The US FDA also record recalls, market withdrawals and safety alerts.[38] The databases representing data between 2018 and 2023 was searched using the term "petfood" (Appendix B). Table 16 outlines 24 entries which includes, "raw meat" within the description, and all were recalled due to the presence of *Salmonella*, *Listeria monocytogenes* and/or STEC. Four of these entries were linked to cases of human illness outbreaks, with details outline in Section 3.2.2. All petfood entries identified are outlined in Appendix C, Table 23.

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[32] https://recalls-rappels.canada.ca/en/alert-recall/primal-patties-dogs-beef-formula-recalled-due-listeria-monocytogenes (Accessed 26 April 2023)
[33] https://www.canada.ca/en/public-health/services/public-health-notices/2020/outbreak-e-coli-frozen-raw-pet-food.html\ (Accessed 14 June 2023)
[34] https://recalls-rappels.canada.ca/en/alert-recall/radagast-pet-food-inc-recalls-various-rad-cat-raw-diet-pet-food (Accessed 14 June 2023)
[35] https://recalls-rappels.canada.ca/en/alert-recall/radagast-pet-food-inc-recalls-rad-cat-raw-diet-free-range-pet-food (Accessed 14 June 2023)
[36] https://ec.europa.eu/food/food/rasff-food-and-feed-safety-alerts_en (Accessed 26 April 2023)
[37] https://www.accessdata.fda.gov/scripts/ImportRefusals/index.cfm (Accessed 24 January 2023)
[38] https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts (Accessed 31 January 2023)

Table 15: European Union Rapid Alert System for Food and Feed entries including raw petfood between 2020 – April 2023 [1]

Date	Issue	Country of origin	Notifying country	Classification[2]	RASFF reference no.
22/03/2023	*Salmonella* in raw petfood	Netherlands	Belgium	information notification for follow-up	2023.1931
26/04/2022	*Salmonella enterica* subsp.*diarizonae* in raw dog feed from Norway	Norway	Norway	alert notification	2022.2415
8/03/2022	*Salmonella* Infantis in raw petfood for cats	Netherlands	Belgium	information notification for follow-up	2022.1372
22/12/2021	*Salmonella* Typhimurium in raw petfood from the Netherlands	Netherlands	Belgium	information notification for follow-up	2021.7079
29/09/2021	*Salmonella* (in 3 out of 5 samples /25g) in frozen raw dog food from Germany	Germany	Germany	information notification for follow-up	2021.5221
27/04/2021	*Salmonella* in raw petfood from Netherlands	Netherlands	Belgium	information notification for follow-up	2021.2096
12/03/2021	*Salmonella* Typhimurium in raw petfood from The Netherlands	Netherlands	Belgium	alert notification	2021.1293
23/02/2021	*Salmonella* Infantis in raw petfood for dogs	Netherlands	Belgium	information notification for follow-up	2021.0932
14/07/2020	Possible presence of *Salmonella* Java in frozen raw dog food products	United Kingdom	United Kingdom	alert notification	2020.2858
26/06/2020	Enterobacteriaceae in frozen raw pet food from Austria	Austria	Slovenia	information notification for follow-up	2020.2622
24/06/2020	Enterobacteriaceae in frozen raw pet food from United Kingdom	United Kingdom	Slovenia	information notification for follow-up	2020.2580
23/01/2020	*Salmonella* in raw petfood	Netherlands	Belgium	alert notification	2020.0349

Abbreviations: Not stated (NS)
Notes: [1] Data extract from the European Union Rapid Alert System for food and feed website: https://ec.europa.eu/food/food/rasff-food-and-feed-safety-alerts_en (Accessed 30 April 2023)
[2] Alert notifications are sent when a food or feed presenting a serious health risk is on the market and when rapid action is required. Information notifications are used when a risk has been identified about food or feed placed on the market but the other RASFF members to not have to take rapid action as the product may not have reached their market or no longer in their market, or the nature of the risk does not require rapid action.

Table 16: Recalls, market withdrawals and safety alerts for raw meat petfood in the United States and Canada (2018 - 2022)[1]

Date	Company/Brand	Product	Pathogen	Country (and distribution). Details	Human/animal illness linked[2]
Aug-22	Darwin's	Raw meat cat food	*Salmonella* Typhimurium and *Salmonella* Kentucky	US (not stated). Caution only.	**Yes: Animal illness of three kittens. No human cases.** https://www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-cautions-pet-owners-not-feed-certain-lots-darwins-natural-pet-products-due-salmonella#:~:text=The%20U.S.%20Food%20and%20Drug,kittens%20in%20a%20single%20household.(Accessed 7 June 2023)
Jul-22	Primal Petfood	Raw beef (frozen)	*Listeria monocytogenes*	US (3 US states and British Columbia, Canada). Voluntary recall	No
Aug-21	Top Quality Dog Food	Ground raw meat	*Salmonella* and *L. monocytogenes*	US (8 US states). Voluntary recall	No
Mar-21	Bravo Packing Inc.	Raw meat (frozen)	*Salmonella* and *L. monocytogenes*	US (nationwide). Voluntary recall	No
Nov-20	Albright's	Raw meat (frozen)	*Salmonella*	US (10 US states). Voluntary recall	**Yes: One animal illness. No human cases.** https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/albrights-raw-dog-food-recalls-chicken-recipe-dogs-because-possible-salmonella-health-risk#:~:text=The%20product%20is%20labeled%20Albright's,to%208%2F27%2F20. (Accessed 7 June 2023)
Jun-20	Carnivora	Raw meat (frozen)	STEC O157	Canada (4 provinces but potentially nationwide). Consumer level recall.	**Yes: Five human cases.** https://www.canada.ca/en/public-health/services/public-health-notices/2020/outbreak-e-coli-frozen-raw-pet-food.html (Accessed 7 June 2023)
Aug-19	Aunt Jeni's	Raw petfood (frozen)	*Salmonella* Infantis and *L. monocytogenes*	US (not stated). Caution only.	Not stated
Sep-19	Performance Dog (Bravo Packaging Inc)	Raw petfood (frozen)	*Salmonella* and *L. monocytogenes*	US (not stated). Caution only	Not stated
Aug-19	Texas Tripe Inc.	Raw petfood (frozen)	*Salmonella* and *L. monocytogenes*	US (24 US states). Caution only	Not stated
Apr-19	Thogersen Family Farm	Raw petfood	*L. monocytogenes*	US (not stated). Voluntary recall	No
Mar-19	Darwin's Natural Pet	Raw petfood (frozen)	*Salmonella*	US (not stated). Caution only.	No

Date	Company/Brand	Product	Pathogen	Country (and distribution). Details	Human/animal illness linked[3]
Jan-19	Woody's Petfood Deli	Raw turkey petfood	*Salmonella* Reading	US (not stated). Voluntary recall	**Yes: Linked with outbreak involving raw turkey: 358 human cases** https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 7June 2023)
Dec-18	Columbia River Natural	Raw petfood	*Salmonella* and *L. monocytogenes*	US (not stated). Voluntary recall	No
Oct-18	G&C Raw	Raw dog and cat food	*L. monocytogenes*	US (10 US states). Voluntary recall	No
Sep-18	Radagast Pet Food Inc.	Raw petfood	*L. monocytogenes*	Canada (manufactured in US). Consumer level recall	No
Sep-18	Performance Dog (Bravo Packing Inc)	Raw petfood	*Salmonella*	US (nationwide). Voluntary recall	No
Jul-18	Radagast Pet Food Inc.	Raw pet food	*L. monocytogenes*	Western Canada (manufactured in US). Consumer level recall.	No
Apr-18	OC Raw Dog	Raw dog food	*L. monocytogenes*	US (7 US states). Voluntary recall	No
Mar-18	Blue Ridge Beef	Raw petfood	*Salmonella* and *L. monocytogenes*	US (5 US states). Voluntary recall	No
Mar-18	Raw Basics	Raw pork-bison dog	*Salmonella*	US (4 US states). Voluntary recall	No
Mar-18	Steve's Real Food	Raw dog food	*Salmonella*	US (21 US states). Voluntary recall	No
Feb-18	Northwest Naturals	Raw dog food	*L. monocytogenes*	US (6 US states). Voluntary recall	Not stated
Feb-18	Christofersen Meats Company, Swanson Meats/Raw for Paws	Raw meat	*Salmonella* Reading	US (not stated). Voluntary recall	**Yes: Linked with outbreak involving raw turkey: 358 human cases .** https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 7June 2023)
Oct-16 Feb-18[2]	Darwin's Natural Pet Products	Raw petfood	*Salmonella* and/or, *L. monocytogenes*, STEC O128,	US (not stated). Multiple voluntary recalls.	**Yes: Animal illness linked to pet food. Also linked with *Salmonella infantis* outbreak involving raw chicken: 129 human cases.** https://public4.pagefreezer.com/browse/FDA/03-05-2022T01:45/https://www.fda.gov/animal-veterinary/news-events/updated-fda-investigates-pattern-contamination-certain-raw-pet-foods-made-arrow-reliance-inc. (Accessed 8 June 2023) https://www.cdc.gov/salmonella/infantis-10-18/index.html (Accessed 7 June 2023)

Abbreviations: United States of America (US), Shiga toxin-producing *E. coli* (STEC).

Notes:[1]Data was extracted from the United States Food and Drug, Association Recalls, Market Withdrawals and Safety Alerts Website: https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts and Health Canada recalls, advisories and safety alerts (https://recalls-rappels.canada.ca/en) (Accessed 7 June 2023).

[2] Five recalls noted for this company between October 2016 and February 2018.

[3] Those entries with human illness cases linked to outbreaks described in Table 8.

3.6 CASE-CONTROL AND SOURCE ATTRIBUTION STUDIES FOR THE MICROBIAL PATHOGENS OF INTEREST FOR NEW ZEALAND

Expert elicitation studies have estimated that 75% campylobacteriosis, 20% of STEC O157:H7 infection, 40% of non-O157 infection, 75% of yersinosis, 62% of salmonellosis cases in New Zealand are foodborne (Cressey et al. 2019, Soboleva 2021, Pattis et al. 2022). It has been estimated by expert consultation that 88% of listeriosis incidence is due to foodborne transmission (Cressey et al. 2019). However, the human infections from sources other than food are unlikely and the fact that the estimate is less than 100% is likely an artefact of the expert elicitation methodology (Pattis et al. 2022). The estimate of foodborne proportion of *T. gondii* cases in New Zealand was 28% as determined by the expert elicitation study. However, animal contact, food and environmental exposures were reported to be of approximately equal importance for the transmission of *T. gondii* in New Zealand (Cressey et al. 2019).

Internationally, *Salmonella* is often associated with food products of animal origin, including eggs and chicken. However, non-poultry food sources are also often implicated (e.g., alfalfa sprouts). Non-food sources include contact with infected animals or contaminated water or environments (King et al. 2011).

For campylobacteriosis, a source-attributed case-control study of notified human cases was undertaken in 2018 - 2019. The majority of cases (84%) were infected with strains attributed to a poultry source, while 14% were attributed to a cattle source. Approximately 90% of urban campylobacteriosis cases were attributed to poultry sources, compared with almost 75% of rural cases. Although the consumption of poultry was not identified as a significant risk factor, specific risk factors related to poultry meat preparation and consumption did result in statistically significantly elevated odds ratios (Lake et al. 2021). Contact with a pet was not identified as a significant risk factor for campylobacteriosis. There were no specific questions or sampling of raw meat petfood included in the study.

A case-control study on campylobacteriosis in Australia (2018 – 2019) estimated 42% of campylobacteriosis cases in the study population were attributed to any chicken consumption (cooked or uncooked) but owning a pet dog aged less than 6 months was also identified as an important risk factor with 9.6% of attributed cases (Cribb et al. 2022). Other international case-control studies have reported up to 25% of human campylobacteriosis cases attributed to pet sources (Mughini Gras et al. 2013, Rosner et al. 2017, Mughini-Gras et al. 2021). For STEC infection, a case-control study found contact with animal manure, presence of cattle within a meshblock (the smallest geographical unit) and contact with recreational waters to be the most significant risk factors for human infection, rather than consumption of food products (Jaros et al. 2013). Raw meat, unpasteurised milk, dairy products and raw produce are common food sources of STEC infection.[39]

A New Zealand study that used WGS to characterise *L. monocytogenes* from human cases between 1999 and 2018, identified clusters of isolates with low genetic diversity, potentially suggesting a common source of infection, but incomplete epidemiological data prevented a comprehensive retrospective epidemiological investigation (Rivas et al. 2021b).

[39] https://www.mpi.govt.nz/food-safety-home/food-poisoning-symptoms-causes/e-coli-stec-infection-symptoms-and-advice/ (Accessed 28 March 2023)

3.7 HEALTH BURDEN OF INFECTION WITH THE MICROBIAL PATHOGENS OF INTEREST

The New Zealand human health burden for disease has been estimated using surveillance data for 2013 and includes an estimate for foodborne salmonellosis, campylobacteriosis, listeriosis, STEC infections and yersiniosis of 74, 622, 179, 156 and 66 disability adjusted life years (DALYs)[40] (Cressey et al. 2014). The study does not estimate the fraction of the burden of human disease associated with raw meat petfood as a vehicle.

No estimates for burden of illness to New Zealand from toxoplasmosis were available.

[40] The calculation for DALYs is the number of years of life lost to mortality combined with the number of years lived with disability.

4 EVALUATION OF RISK

Key findings

- There were no published risk assessments specific for raw meat petfood identified in the literature. International literature highlights the risk factors or route for human infection by *Salmonella* including both handling of *Salmonella*-positive food and contact with pets, especially among young children. Raw meat feeding has been identified as a major risk factor for *Salmonella* in dog stools.
- Raw meat petfood products that appear as chilled fresh meat (i.e., not frozen) containing a preservative and frozen product available in the supermarkets are likely to have the greatest market share of the raw pet food market in New Zealand. Frozen product is most commonly available from pet food stores and online suppliers and contain a variety of meat combinations, including wild hunted animals and no preservatives.
- Limited information is available on the prevalence of microbial hazards in commercial raw meat petfood in New Zealand, but evidence from raw meat processed for human consumption chains and internationally suggests that these pathogens are likely present in these products. It is unclear whether preservatives or freezing would deactivate or inhibit pathogens in these products over time.
- Due to insufficient New Zealand data, it is not currently possible to estimate the human illness risk associated with exposure to microbial pathogens in commercial raw meat petfood. The large number of raw meat petfood products on the market and their widespread availability suggests a significant number of people are buying raw petfood in New Zealand. These products are likely to have fewer critical control steps than meat for human consumption, and thus they present a greater risk of exposure to pet owners handling them. Better information on the microbiological quality of raw petfood products on the market would greatly assist the assessment of risk.

4.1 STUDIES INDICATING RAW PETFOOD AS A RISK FACTOR FOR HUMAN ILLNESS

There were no published risk assessments specific for raw meat petfood identified in the literature.

Foodborne pathogens in raw meat petfood pose risks both to the animals consuming them and to those who care for them and share their households. Established risk factors or routes for human infection by *Salmonella* include both the handling of *Salmonella*-positive food and contact with pets, and raw feeding has been identified as a major risk factor for *Salmonella* in dog stools (Finley et al. 2008, Domingues et al. 2012, Freeman et al. 2013, Reimschuessel et al. 2017).

Multi-state case-control studies in the US were conducted in association with an outbreak of *Salmonella* Schwarzengrund primarily affecting young children (48% of cases were age 2 years or younger) which was attributed to dry dog and cat food. Case-households were significantly more likely than control households to report contact with dogs (matched odds ratio [mOR]: 3.6) and an association with a brand of dry petfood (mOR; 6.9). Illness amongst infant case-patients were significantly associated with feeding pets in the kitchen (OR: 4.4). The outbreak strain was isolated from opened bags of dry dog food from a particular processor, faecal specimens from dogs that ate the product, and an environmental sample and unopened product from the processor. More than 23,000 tonnes of petfood were recalled. After additional outbreak-linked illnesses were identified during 2009, the company recalled 105 brands of dry petfood and permanently closed the processing plant. Although this outbreak involved a dry petfood, it highlights the importance of proper handling and storage of petfood in the home to prevent human illness, especially among young children (Centers for Disease Control 2008, Behravesh et al. 2010).

A US survey of 1,040 pet owners found that almost all pet owners (93%) interacted with their pets, and most cuddled them, allowed them to lick them and slept with their pets. Less than one-third of pet-owners washed their hands with soap after interacting with petfood. Many owners (78%) were also unaware of petfood recalls or outbreaks associated with foodborne pathogens (Thomas and Feng 2020).

A study in Brazil that interviewed pet owners feeding raw-meat based diets, found that a large number of respondents did not recognise that these raw-meat based diets pose health risks for their animals (87.9%) or humans (98.8%), even though 34.8% of respondents declared having at least one individual at high risk of infection in contact with their pets (Viegas et al. 2020). In comparison, a Finnish study found only 0.2% of 16,475 households self-reported that a member of their household became ill due to the raw products fed to their pet(s). Only three of those households had laboratory confirmation of a pathogen in the human sample and confirmed also in the raw petfood. The authors indicated that this result would suggest very minimal human risk from feeding raw meat-based diets to pets, but there would be generally a wide degree of underreporting of and underdiagnoses of human illness attributed to foodborne pathogens (Anturaniemi et al. 2019).

Although the attribution of human campylobacteriosis to pet sources in New Zealand has been recently reported to be low risk (Lake et al. 2021), the proximity between pets and humans, and the frequent of carriage of *C. jejuni* by these animals, human exposure to *Campylobacter* from pets may be more important than thought, and pets may constitute a significant source of human exposure to *Campylobacter*. Further work is required to assess with accuracy the implication of pets in human campylobacteriosis (Mughini Gras et al. 2013, Thépault et al. 2020, Cribb et al. 2022).

A case-control study on campylobacteriosis in Australia (2018 – 2019) estimated 42% of campylobacteriosis cases in the study population were attributed to any chicken consumption (cooked or uncooked) but owning a pet dog aged less than 6 months was also identified as an important risk factor with 9.6% of attributed cases (Cribb et al. 2022). Other international case-control studies have reported up to 25% of human campylobacteriosis cases attributed to pet sources (Mughini Gras et al. 2013, Rosner et al. 2017, Mughini-Gras et al. 2021).

4.2 ESTIMATE OF RISK FOR NEW ZEALAND

The information located for this discussion document suggests that commercial raw meat petfoods are made with a variety of meat species, including wild hunted animals. Commercial raw meat petfood likely to have the greatest market share would be those within the major supermarket chains that appear as fresh meat in pottles and contain a preservative. However, there is a predominance of frozen product available in pet stores, speciality stores and directly online (with couriering).

There is limited information available on the prevalence of pathogens in commercial raw meat petfood in New Zealand. However, the current evidence based on data from raw meat processed for human consumption, together with international data highlight that the microbial hazards of interest are likely prevalent in these types of products. It is unclear whether the preservatives included in fresh products on sale would deactivate or inhibit the growth of these pathogens during storage. It is also unknown whether these fresh products have been previously frozen. Frozen product would decrease the risk of some pathogens, such as *Campylobacter* and *T. gondii*, that are sensitive to freezing, but not for other pathogens such as *Y. enterocolitica* or STEC, that can survive freezing. Fundamentally, raw meat petfood undergoes minimal processing and has a greater risk of pathogen presence compared with other petfood that is (heat) treated.

Although there has been no reported outbreaks or human illness attributed to commercial raw meat petfood in NZ, international examples of outbreaks of human disease directly linked to raw meat petfood fed to pets have been reported. As outlined in Section 2.7.1, there are multiple transmission routes of human infection associated with raw meat petfood but direct contact with contaminated petfood and with animals fed these foods have been noted as important risk factors. As the international trend towards 'fresh' and 'natural' petfood grows, it is possible that this market will grow and more New Zealanders will purchase these products, increasing their risk of exposure to microbial pathogens and illness. Young children, older adults, or immunocompromised persons within these households of pet fed raw meat diets might have a higher risk of severe illness if exposed to these microbial pathogens. Indeed, children have been observed to have disproportionate risk following outbreak investigations involving petfood.

Feeding of raw meat petfood also contributes an increased risk for animal health and the shedding of pathogens into pet owners' environments where indirect or secondary transmission of illness can occur. The degree of risk from this route is unclear but internationally, outbreaks have been reported to be linked to companion animals asymptomatically shedding. New Zealand has a high percentage of pet ownership in households, and many consider their pets a part of the family with an increasing trend for these pets to share the household environment with their owners. Together with other pet owner practices such as poor hygiene with hand washing following contact with raw meat and their pets, and inappropriate cleaning of utensils and feed bowls, the risk for human illness may also increase.

Based on international literature, it is likely that most raw meat feeding-associated human cases are sporadic and not investigated for a cause. This may represent an area of under-reporting. Implementation of WGS within public surveillance protocols has identified two reported outbreaks associated with raw meat petfood internationally. The high resolution of WGS and clustering tools has been able to identify clusters of human cases quickly, and with prompt follow-up has resulted in identifying a common source.

Due to insufficient NZ data, it is not currently possible to estimate the human illness risk associated with the exposure to microbial pathogens in commercial raw meat petfood. The large number of raw meat petfood products on the market and widespread availability suggests a significant number of people are buying raw petfood in New Zealand. These products are likely to have fewer critical control steps than meat for human consumption, and thus they present a greater risk of exposure to pet owners handling such meat. Better information on the microbiological quality of petfood products on the market would greatly assist the assessment of risk.

5 AVAILABILITY OF CONTROL MEASURES

Key findings

- New Zealand petfood manufacturers are regulated by several legislations. Primary petfood processors must comply with the regulations within the Animal Product Act (APA) 1999 including operating a risk management programme (RMP). Secondary petfood processors may operate under various scenarios but can operate under an RMP for commercial reasons, but further petfood processors must implement a tracking system under the APA and must be listed with MPI. Some processors operate as primary and secondary processors.
- The Petfood Processing Operational Code (Code) provides guidance to petfood processors to comply with the legislative requirements. There are no specific microbiological limits for commercial raw meat petfood in New Zealand. However, the Code provides guidance and recommendations for microbiological testing of raw meat petfood for primary and secondary processors. Internationally, the European Union and the United States of America have microbiological limits for raw met petfood products that focus on the presence/absence of *Salmonella* and/or *L. monocytogenes.*
- International studies have shown that there is a need to raise awareness of the risks involved for both pet owners associated with raw meat petfood feeding and hygiene practices to help limit potential cross contamination within a household. As pet owners look towards social media for information, the need for credible and trust-worthy evidence-based messages and recommendations is required. Some countries provide food safety campaigns and fact sheets that aim to educate the public on proper petfood handling, storage and hygiene practises. Veterinarians and petfood associations may also provide credible advice for pet owners on suitable products if raw meat petfood is preferred.
- Identifying and diagnosing petfood borne illness is crucial in protecting both animal and human health. Veterinary diagnostic laboratories can play a significant role in public health illness by contribute information within public health surveillance protocols.

5.1 RISK MANAGEMENT STRATEGY

MPI has a strategy and work plan to manage the risk of foodborne *Campylobacter* in New Zealand. Since 2006, the strategy has focused on reducing Campylobacter contamination of chicken meat and has resulted in a reduced foodborne *Campylobacter* illness in New Zealand by over 50%. The aim is to further reduce foodborne *Campylobacter* illness by 20% by 2025, with an action plan that focuses on improving controls (biosecurity) at farm level, improving hygiene during primary processing and re-evaluating the regulatory target for *Campylobacter* on chilled chicken carcasses and enhanced consumer education[41] (Ministry for Primary Industries 2017).

[41] https://www.mpi.govt.nz/science/food-safety-and-suitability-research/campylobacter-risk-management/ (Accessed 21 March 2023)

5.2 CURRENT RISK MANANAGMENT MEASURES

5.2.1 Current legislation and codes

New Zealand petfood manufacturers are currently regulated by the following legislations and code of practice, with the details of each outlined in Appendix E:

- The Animal Welfare Act 1999 [42]
- ACVM Act 1997 [43]
- Animal Products Act (APA) 1999 [44]
- Animal Products Regulations 2021[45]
- Petfood Processing Operational Code (Code) (Ministry for Primary Industries 2018b)

Requirements for petfood manufacturing under the APA depend on whether a processor is either:

a) primary petfood processors that slaughter and dress animals and may also make petfood – who must comply with the APA 1999, including operating under a risk management programme (RMP)

b) secondary petfood processors that process carcasses after post-mortem examination and can include cutting, boning of carcasses and cuts, further processing and manufacturing of petfood, packing, refrigeration and storage. Animal material for all secondary processing of petfood must be procured only from regulated sources that are registered or listed businesses that operate under regulatory control of MPI, which for raw meat petfood in scope of this discussion document include:

- Primary processors operating an RMP under the APA.
- Further petfood processors that implement a tracking system under the APA.
- Petfood manufacturers that have a documented system for manufacturing under the ACVM.

There are scenarios where secondary processors may operate under several regulatory scenarios. For example, those that are involved in “further petfood processing” that may process petfood that is made from or contain any raw material such as raw meat, offal and poultry for domestic sale only or export to a country that does not require official certification from MPI for petfood consignments. These petfood processors must be listed with MPI and implement a documented tracking system that shows that all animal materials used in the petfood processing are procured from regulated sources. These activities are audited by MPI. The frequency of auditing depends on the type of manufacturing being undertaken.

There may also be secondary processors that choose to operate under an RMP for commercial reasons (for example, customer requirements).

[42] https://www.legislation.govt.nz/act/public/1999/0142/latest/DLM49664.html (Accessed 13 January 2023)
[43] https://www.legislation.govt.nz/act/public/1997/0087/latest/whole.html (Accessed 23 March 2023)
[44] https://www.legislation.govt.nz/act/public/1999/0093/latest/DLM33502.html (Accessed 13 January 2023)
[45] https://www.mpi.govt.nz/legal/legislation-standards-and-reviews/redesign-of-animal-products-and-wine-regulations-and-notices/ (Accessed 23 March 2023)

All commercially produced petfood, including raw meat petfood must meet the requirements for oral nutritional compounds as set out in ACVM Act 1997.[46,47]

The ACVM regulations[45] require all petfood processors to:

- ensure that the product is fit for purpose for importation, manufacture, or sale (regulation 7). Within this regulation the following is relevant for the microbial hazards of interest for this discussion document, whereby it states that an exempt agricultural compound that is imported, manufactured, or sold must be such that where used as recommended, it will not:
    - spread organisms to a level or in a manner that could be harmful to humans; or,
    - be toxic to animals treated with or exposed to the compound to an extent that causes unnecessary or unreasonable pain or distress; or
    - transmit disease result in physical harm or cause unnecessary pain and distress to animals treated with or exposed to the compound; or,
    - otherwise create or be likely to create any of the risks specified in section 4(a) of the Act, which includes prevents risks to public health and animal welfare.
- ensure that the product is fit for purpose from the use end (regulation 8), whereby the use of the product does not do anything described in regulation 7 (as above).
- have a documented system for manufacturing and that a system is followed with adequate records kept (regulation 9 and 14).
- provide specified information on the product label (regulation 12).
- meet the specific requirement for oral nutritional compounds listed in Schedule 2, Part B.
- not make misleading statements about the product – in particular therapeutic claims (regulation 13).

In addition, requirements under the animal product regulations relevant to petfood processing include:

- Transportation and refrigeration of bulk animal material or animal production for animal consumption.
- Good Operating Practice, including for premises and equipment; cleaning and maintenance; pest control and exclusion of animals; personnel, contractors and visitors and good record keeping.
- Restrictions of supply of animal material for animal consumption including medium risk material, which must be treated to reduce risk (such as, by rendering) before being made available for animal consumption. By way of example, medium risk animal materials include:

[46] https://www.legislation.govt.nz/act/public/1997/0087/latest/whole.html (Accessed 23 March 2023)
[47] https://www.legislation.govt.nz/regulation/public/2011/0327/latest/whole.html?search=ts_regulation_Agricultural++Compounds_resel&p=1#DLM3983201 (Accessed 7 June 2023)

  - Material, derived from an animal carcass, containing or suspected to contain residues of agricultural compounds or veterinary medicines, or toxic natural substances that may cause harm unless the material is processed or treated so that the levels of residue or substance is reduced to a level that is unlikely to result in harm.
  - Animal material or animal product that is not fit for animal consumption without further processing or treatment.
  - Material that has come into contact with other medium risk material.
  - Material derived from animals suspected to be diseased, or that are slaughtered for specific disease eradication purposes, unless the slaughtered animals are passed as fit for human consumption or minimal risk material for animal consumption.
  - Material from farmed animals that have died in the field or from home kill or recreational catch.
  - Material that is or has come into contact with any animal material or animal product in relationship to which any person is required under direction of the Act, to take preventative or corrective action.
- Competencies of personnel training particularly for ante- and post-mortem examinations. Schedule 1 outlines the requirements for post-mortem examination procedures and disposition tables for domestic petfood farmed mammals. In particular:
  - Bloody diarrhoea due to salmonellosis must be deemed as condemned or medium risk.
  - Toxoplasmosis is listed under disease or condition, which is not grossly identifiable and can pass for petfood, but it must be included as a hazard under the RMP (an identified hazard in the source of raw material that must be further analysed and managed where possible by the operators RMP).
- Requirements for chicken producers who do not operate under an RMP who produce chickens, including layers chickens and dealing with *Salmonella* Enteritidis positive results.
- Labelling of animal material or animal products intended for animal consumption.
- Requirements for registered suppliers of killed hunted animals, including restrictions on land from which hunted animals can be procured, killing, evisceration and transport requirements.

The Code provides guidance to operators that are involved in the primary and secondary processing of petfood and the transport of animal material or product for processing to petfood, in order to comply with the requirements of the APA and any other relevant legislations (Ministry for Primary Industries 2018b). The Code specifies the following minimal risk meat materials that can be used in raw petfood:

- materials derived from farmed mammals and birds slaughtered for animal consumption under an RMP and passed as suitable for petfood use.
- materials derived from farmed animals slaughtered for human consumption under an RMP and passed as fit for human consumption but is not going to be used in this way for

commercial reasons (for example, edible offal deemed fit for human consumption but sold for petfood use).

- Materials derived from famed animals slaughtered for human consumption under an RMP that passed ante-mortem examination but deemed unfit for human consumption at post-mortem examination but deemed suitable for petfood.
- Materials derived from wild hunted animals and passed as suitable for petfood use.

5.2.2 Microbiological limits for raw meat petfood products

New Zealand and Australia

No microbiological limits are set specifically for raw meat petfood in Schedule 27 of the Australia New Zealand Food Standards Code.[48]

Within the Code, guidance is provided that when no regulatory limit is specified and when necessary to define the acceptability of the petfood, the operator is expected to establish their own limits for the types of petfood they produce. When establishing operator-defined limits, the manufacturer should consider:

- The type and nature of the petfood (for example, limits for raw petfood will be different from those for manufactured petfood).
- The hazard(s) reasonably likely to occur in the petfood.
- The potential risks to the pet through direct consumption of the petfood and,
- The risk to the pet owner or handler through direct or indirect contamination from handling, preparing, or storing of petfood.

The manufacturer should also ensure that the defined limited are scientifically justifiable and appropriate to the petfood and considering:

- Its intended use.
- Its intended consumer and expected handling after leaving the RMP and;
- That they are consistently achievable under normal operating conditions.

The NZPFMA provides its members further guidelines and recommendations for the microbiology testing of raw meat for primary and secondary processors (New Zealand Petfood Manufacturers Association 2013).

The guidelines provide the following key recommendations:

- Sample finished product ready for despatch at a rate of one sample (an entire intact package) every five tonne, with a minimum of one sample per fortnight.
- Samples should be taken in proportion of the product being processed so that over the course of a year the percentage of samples taken for each species is approximately the same as the percentage of the volume of each product produced.
- Transportation of samples to the analysing laboratory to follow NMD recommendations which includes storage and transportation in insulated containers with the aim of below 5°C for fresh samples and below -12°C for frozen samples.
- Analysis of the sample must be initiated within 24 h of collection.

[48] https://www.foodstandards.gov.au/code/Documents/Sched%2027%20Micro%20limits%20v157.pdf (Accessed 7 June 2023)

- Every sample should be analysed for Aerobic Plate Count, *E. coli* and *Salmonella*. *Salmonella* analyses should be performed to the presumptive positive stage.
- Each operator should establish microbiological criteria within their RMP, with a review of the targets from time to time as more data becomes available. The following draft standard is outlined as follows:

    - All chilled and frozen raw meat petfood:
        - Aerobic plate count: 1,000,000 cfu/g
        - *E. coli:* 1,000 cfu/g
        - *Salmonella* per 25 g: Not detected.

The NZPFMA were unable to disclose if any members were applying these recommendations or provide any industry data. It is likely that processors operating with an RMP do undertake microbiological testing, but the criteria and testing frequency is unknown.

In Australia, petfood is self-regulated and petfood companies can opt to become a voluntary member of the PFIAA that apply voluntary industry standards. The Australian Standard (AS 5812-2017) manufacturing and marketing of petfood requires manufacturers of petfood (including those importing to Australia) to consider the safety risk when establishing HACCP plans for certain ingredients, for contaminants or for residues in ingredients, or in product post-processing.[49] These standards however are not mandatory, but they are strongly encouraged (Standing Council on Primary Industries Pet Food Controls Working Groups 2012). The process of accreditation of AS5812-2017 requires the use of an accredited third-party auditor to verify and provide a report to the PFIAA.

Within the standard, there is a reference list of potential risks, relevant to petfood, arising from raw materials, processing and post-processing incidents. However, some of these are directed towards dry petfood such as maximum levels of mycotoxins.

Salmonella is the only microbiological risk with a criterion within the standard, with an absence in 5 x 25 gm samples (as per PEDIAF-EU).

There are additional criteria for hygienic production specific to meat outlined in a technical report produced by the Primary Industries Ministerial Council (PIMC), which is overseen by state food authorities. In Australia, controls applicable to both pet meat and petfood include quarantine laws for imported products and Australia's generic consumer policy framework.

International context

There are no specific Codex Alimentarius texts related to food safety aspects of commercial raw meat petfood that were identified.

European Union

In the EU, there are a number of legislations applicable to the petfood sector (The European Pet Food Industry 2018).

[49] https://pfiaa.com.au/pet-food-standards/ (Accessed 26 April 2023)

The Animal By-Products Regulations (EC) 1069-2009[50] and 142/2011[51] provides detailed rules on the safety of raw materials of animal origin used in petfood, their processing requirements (including petfood). This includes animal by-products that fall into the 'Category 3' classification, including those that are fit (but not intended) for human consumption and those products processed for human consumption but removed from the food chain for various reasons not relating to a risk to public or animal health.

In addition, certain by-products that are unfit for human consumption are permitted, subject to regulations on the fitness of the source animals for human consumption, the manner of slaughter and post-mortem inspection. In practise, many producers restrict their animal by-product sources to those considered fit for human consumption, but are, nonetheless, not intended to be eaten raw (Wales and Davies 2021).

Regulation (EC 142/2011, Annex XIII) addresses some of the risk specific to raw petfood which includes:

- Restricted list of raw materials approved for use.
- Microbiological limits (listed in Table 17)
- Packaging requirements i.e., new, clean and leak proof.

Table 17: Microbiological limits for raw meat petfood products in the European Union

Microbial analyte	n	c	m	M
Salmonella (per 25 g)	**5**	**0**	**0**	**0**
Enterobacteriaceae (colony forming units per 1 g)	**5**	**2**	**10**	**3000**

Notes: n = number of samples to be tested. m = threshold value for the number of bacteria, the result is considered satisfactory if the number of bacteria in all samples dos not exceed m. M = maximum value for the number of bacteria; the result is considered unsatisfactory if the number of bacteria in one or more samples M or more; and c = number of samples the bacterial count of which may be between m and M, the sample still being considered acceptable if the bacterial count of the other samples is m or less.

United Kingdom

On exit from the EU, the UK retained EU legislation in its domestic legislation. Guidelines for the manufacturer of raw petfood is available via UK Petfood (United Kingdom Pet Food 2017) and in parts is based on guidance from the Department for Environment, Food and Rural Affairs (Defra) which is predominantly applicable for England only. In the UK, Animal By-Products Regulations are enforced through domestic regulations. The guidelines provide some information on microbiological sampling protocols and a checklist of action to take in response to a *Salmonella* testing failure.

United States of America

In the US, petfood is regulated by the US Food and Drug Administration (US FDA). Petfood manufacturers and their suppliers are required to market safe products under the Federal

[50] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009R1069-20140101&rid=1 (Accessed 26 April 2023)
[51] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011R0142-20170529&rid=1 (Accessed 26 April 2023)

Food Drug and Cosmetic Act (FD&CA) of 1938,[52] but petfood and treats are now also regulated under the Food Safety Modernisation Act (FSMA).[53] Requirements for petfood manufacturers to comply with current Good Manufacturing Practices and identify potentially safety hazard and subsequently establish preventative controls for those hazards.

The US FDA considers a petfood to be adulterated under the FD&C Act (section 402(a)(1)) when it is contaminated with pathogenic bacteria including *Salmonella* and *Listeria monocytogenes*. A compliance policy guide for *Salmonella* in food for animals indicates that any *Salmonella* of any serotype is considered an adulterant in products that will not subsequently undergo a commercial heat step or other commercial process that will kill the *Salmonella*. This also includes petfood ingredients such as animal products (United States Department of Health and Human Services Food and Drug Administration 2013).

A guidance document for the manufacture and labelling of raw meat foods for companion and captive non-companion carnivores and omnivores outlines recommendations for industry (United States Department of Health and Human Services Food and Drug Administration 2004).

Although the US FDA is the federal regulatory authority, petfood is also typically regulated in individual states by their departments of agriculture. To facilitate uniform interpretation and enforcement of state regulations, many of those states follow the model laws and regulations set by the Association of American Feed Control Officials (AAFCO).[54] The models augment and complement the US FDA regulations, that cover aspects of labelling not addressed at the federal level. It also sets nutrient standards and specifications for ingredients used in petfood.

As described in Section 3.4, the US FDA's Vet-LIRN network responds to animal food issues and performs non-regulatory testing of animals and suspected petfood. Pet owner complaints including suspect petfood can also be submitted. Animal medical records and owner interview responses are performed to assess if petfood is attributed to animal illness, and if there is a direct link to food then the US FDA will undertake further investigations. This network has been effective in identifying petfood attributed outbreaks in animals and humans (Ceric et al. 2019).[55,56]

Canada

Petfood is not a comprehensively regulated commodity in Canada compared with food for human consumption or livestock feeds. The oversight of petfood by the Canadian Food Inspection Agency (CFIA) is limited to compliance with regulatory requirements for import and export of animal products and by-products.[57] CFIA inspect petfood facilities regularly to ensure regulatory and export requirements are being met, especially as many Canadian

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[52] https://www.fda.gov/regulatory-information/laws-enforced-fda/federal-food-drug-and-cosmetic-act-fdc-act (Accessed 12 April 2023).
[53] https://www.fda.gov/food/guidance-regulation-food-and-dietary-supplements/food-safety-modernization-act-fsma (Accessed 12 April 2023)
[54] https://www.aafco.org/ (Accessed 7 February 2023)
[55] https://www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-investigates-contaminated-pig-ear-pet-treats-connected-human-salmonella-infections (Accessed 17 March 2023)
[56] https://www.fda.gov/animal-veterinary/science-research/how-fdas-center-veterinary-medicine-improved-human-healthcare-during-outbreak-linked-puppies (Accessed 17 March 2023)
[57] https://inspection.canada.ca/animal-health/terrestrial-animals/exports/pet-food/pet-food-treats-and-chews/eng/1670879398171/1670879399109 (Accessed 23 March 2023)

petfood manufacturers also export to the US and other countries with strict regulations for animal health and food safety.

Petfood, pet treats and pet chews that contain animal products and by-products are regulated under the Health of Animals Regulations if they are imported into Canada.[58] According to the Petfood Association of Canada website,[59] most (97%) of imported petfood is from the US who are regulated by the US FDA and USDA.

5.3 OTHER RISK MANAGEMENT MEASURES

5.3.1 Petfood associations

There are a number of petfood associations across the world that have similar remits in supporting manufacturers of petfood (Appendix B, Table 20). Many of the associations, including the NZPFMA are member-based and focus on various aspects of petfood manufacturing to help ensure product safety. Some of these associations provide guidance for the safe manufacture of petfood within applicable regulatory framework and provide guidance for safety criteria facilitating international trade.

The World Organisation for Animal Health (WOAH) Terrestrial Animal Health Code also sets international standards for animal health, welfare and veterinary public health, which includes guidance on exporting petfood products.[60]

5.3.2 Risk communication

International studies have shown that there is a need to raise awareness of the risks involved for both pet owners associated with raw meat petfood feeding and hygienic practices to help limit potential cross contamination within the household (Solís et al. 2022) (Westgarth et al. 2008, Stull et al. 2012, 2013, Bojanić et al. 2017). Good hygienic practices such as hand-washing before and after feeding, appropriate cleaning of bowls and contact surfaces and adequate storage can decrease direct risk for humans (Weese and Rousseau 2006).

Pet owners can also reduce their risk of acquiring illness associated with these microbes by not feeding raw food diets to their pets (Finley et al. 2006). The growing popularity of raw meat-based diets may be partly driven by social media and other information sources that provide anecdotes that support the benefits of raw feeding and 'natural' foods to advance pet health (Morgan et al. 2017, Schleicher et al. 2019, Empert-Gallegos et al. 2020, Bulochova and Evans 2021b)). However, there is currently insufficient scientific evidence of these health benefit claims for raw-meat diets (Schlesinger and Joffe 2011, Freeman et al. 2013, Morelli et al. 2019, Ahmed et al. 2021). There is, however, plausible evidence that indicates that raw meat-based diets can cause animal health harm, with nutritional imbalances (Schlesinger and Joffe 2011, Lumbis and Chan 2015, Vecchiato et al. 2022).

Currently there are no legal requirements specific to the provision of consumer food safety guidance regarding raw meat feeding in New Zealand. There is a need for credible and

[58] https://inspection.canada.ca/animal-health/terrestrial-animals/imports/import-policies/animal-products-and-by-products/pet-food/eng/1321129023397/1321129556426 (Accessed 3 February 2023)
[59] https://pfac.com/learn-about-pet-food/#learn_tabs|3 (Accessed 3 February 2023)
[60] https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/ (Accessed 26 April 2023)

consistent strategies to inform pet owners about the potential implications associated with feeding raw meat to pets, as well as safe food handling practises (Bulochova and Evans 2021b). Some countries have petfood safety campaigns and information that aim to educate the public on proper raw meat petfood. For example, some campaigns provide information about raw meat diets for companion animals and the hazards, as well as appropriate raw meat petfood handling, storage and handwashing.[61, 62, 63] This also includes veterinarians and some petfood associations (Appendix B, Table 20), that provide advice of best practise of raw-meat diets for companion animals.[64, 65] If a pet owner has a preference for raw meat petfood, but is concerned about the safety of these products, then a HPP treated raw meat petfood is recommended (Stogdale 2019).

There will also be an unknown portion of the population that may also feed their pets raw meat, intended for human consumption that is either uncooked/cooked and prepared at home, where the risk communication would also be appropriate.

Identifying and diagnosing petfood borne illness is crucial in protecting both animal and human health. Veterinary diagnostic laboratories can play a significant role in public health illness by contribute information within the public health surveillance protocols (Jones et al. 2019). Hygiene precautions should be reinforced to owners with diarrhoeic animals and discussion of the risk of illness (Hulme-Moir 2022).

5.4 DATA GAPS

The following data gaps have been identified during this research project:

- No up-to-date baseline prevalence (and numbers) data currently available for the microbial hazards in commercial raw petfood available at retail in New Zealand, including those available online. This would be very useful to help inform initial risk assessments. There is also currently no legal requirement for raw meat petfood manufacturers in New Zealand to undertake microbiological testing, but some manufacturers may be undertaking routine microbiological testing as a part of their RMP or official assurance programmes. It would be informative to explore whether these manufacturers are willing to share their testing protocols and data, where possible.
- The manufacturing chain for commercial raw petfood is complex. The number of pathways from primary processing of meat intended for human-consumption and pet consumption is unclear. There is also a lack of data on the prevalence of microbial hazards in animals presented for primary petfood processing. It is also unclear as to which, if any critical control and verification steps are being performed during primary and/or secondary processors of raw meat to help control microbiological hazards in these products.
- Limited information is available regarding the growth and survival of microbial hazards in fresh and frozen product during manufacturing and the shelf-life for these retail products. Determining the preservatives that are predominantly used in products appearing as

[61] https://www.ukpetfood.org/resource/raw-feeding-factsheet.html (Accessed 3 April 2023)
[62] https://www.albertahealthservices.ca/eph/Page14885.aspx (Accessed 3 April 2023)
[63] https://www.fda.gov/animal-veterinary/animal-health-literacy/get-facts-raw-pet-food-diets-can-be-dangerous-you-and-your-pet (Accessed 3 April 2023)
[64] https://www.pdsa.org.uk/pet-help-and-advice/looking-after-your-pet/all-pets/raw-diets (Accessed 3 April 2023).
[65] https://vetnutrition.tufts.edu/2016/01/raw-diets-a-healthy-choice-or-a-raw-deal/ (Accessed 3 April 2023).

fresh meat petfood (as many products do not specify), alongside prevalence data will help establish whether the preservatives and/or freezing would be sufficient to control the microbial hazards in these products.

- Some small suppliers of raw meat petfood also provide dry products. Establishing if the dry products are heated to eliminate microbial hazards would help determine if these products would also present a risk. It is also difficult to ascertain from product information as to whether some retail products are treated with HPP prior to freeze-drying.
- The scale of the raw meat petfood market and the number of New Zealanders that feed commercial raw petfood to their companion animals is unknown. It may be useful to commission a survey designed to gather information about pet owners' motivation towards purchasing raw petfood and their perception and attitudes of food safety risks and their practises with raw petfood handling and storage. This could also include assessments of temperature-time changes that may occur during either, a) from purchasing at the retail outlet and transport home or b) couriering of the product from the supplier to the pet owner's home.
- The risk of direct exposure from feeding raw meat petfood to pets in human disease in New Zealand is not known, as obtaining exposure risk factor information specific to raw petfood is not currently undertaken. There is no official process for veterinarians in New Zealand to report or follow-up on suspected companion animal illness associated with raw meat petfood.
- The role of feeding raw meat petfood to companion animals and risk of that pet symptomatically or asymptomatically shedding microbial pathogens is unclear in New Zealand. The magnitude of risk of indirect exposure pathways from the pets and/or the shared environment to cause human illness is an area where limited information is available worldwide.

These data gaps have impacted the ability of this report to inform on the risk of commercial raw petfood on human health in New Zealand and inform on appropriate risk management measures.

5.5 FUTURE SURVEY SCOPE AND RECOMMENDATIONS

It is recommended that the priority of research is to perform a microbiological survey of commercially available raw petfood products from various suppliers across New Zealand. This will provide initial baseline data to help inform on the risk of these products to human health. There are multiple manufacturers and suppliers of raw meat petfood products available in supermarkets, pet shops, speciality stores and online across New Zealand (some only supply to the North or South Island). A list of commercially available products and manufacturers was generated during the preparation of this discussion document (as outlined in section 2.4.1). This list may be a useful start-point in devising a sampling plan for the survey.

Based on the predominant ingredients observed in commercially raw meat petfood – offal, beef and poultry; the survey could focus on the microbial pathogens that are more associated with these meat components or species, including *Salmonella*, STEC and/or *Campylobacter.* Collecting packing and label information for each product may also help inform on the best ways that packing and labels could be improved for food safety purposes.

For example, whether packing be changed to leak-proof packing, and safe handling and storage instructions be included on the packs.

It is also recommended to perform whole genome sequencing on confirmed bacterial isolates obtained for the target microbial hazards. This genomic information could be compared in combination with the following:

- Bacterial isolates from notified human illness cases that are referred to ESR reference laboratories and sequenced as a part of public health surveillance processes. *Salmonella, L. monocytogenes,* STEC are routinely sequenced. There is a considerable genomic dataset for *Y. enterocolitica* from notified human cases obtained via the Health and Research Council funded project.[66] Permissions from the New Zealand Ministry of Health will be required to use the human clinical data.

- Bacterial isolates from the Animal Surveillance Programme are not routinely whole genome sequenced. All historical *Salmonella* isolates from the programme that were referred to ESR are stored at ESR. A selection of these isolates (of relevant types/serotypes identified through the microbiological survey) could be sequenced and compared with those obtained from other sources. It would also be possible to undertake WGS of isolates from clinical cases of animals, including companion animals alongside the survey.

- *Campylobacter* from human clinical cases is not routinely sequenced. There is however a considerable data set including human, animal and food sources from the source-attribution case-control study and other historical surveillance studies undertaken by Massey University (Marshall et al. 2017, Lake et al. 2021).

- Isolates and/or genomic data from research projects performed in New Zealand for MPI and other programmes. Examples of past projects that could be included are outlined in Appendix A, Table 19. There may be more recent projects that are also relevant including the AMR surveillance in slaughtered animals project.

Depending on the results of the microbiological survey outlined above, follow up research may involve the following:

- Assessment of the primary and secondary processing petfood manufacturing chain to establish the processes and pathways that may be contributing to pathogen numbers in the final product. This would need engagement with the processors and potentially a combination of onsite observations or questionnaires/surveys. This may help identify areas where existing critical control steps and verification is undertaken and where improvements could be made to help reduce the relevant microbial hazards in the final product. A microbiological testing programme may be incorporated to help validate and monitor improvements over time.

- Pet owner surveys would help establish the magnitude of the raw meat petfood market, including those that order online. A survey may be designed to assess the perceptions and attitudes of pet owners towards raw meat petfood, as well as their habits with respect to petfood handling and storage.

Information from the US has indicated that an integrated human and animal health surveillance system can successfully attribute human and/or animal illness and outbreaks to

[66] https://www.hrc.govt.nz/resources/research-repository/unravelling-mysteries-yersiniosis (Accessed 4 April 2023).

commercial petfood products. Integrating sequencing of isolates from clinical cases and suspect foods, alongside epidemiological data are essential to confirm clusters of cases and confirm food sources. Exploring whether a similar system and protocols could be developed in New Zealand may also prove beneficial for public and animal health outcomes.

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APPENDIX A: HAZARD INFORMATION

Table 18: Characteristics of the microbiological hazards in scope

Organism	Infectious dose [1]	Adverse foodborne health effects in humans	Contamination origin [2]	Characteristics [3]	References
Salmonella enterica	10^2 - 10^6 cells	Acute gastroenteritis with or without blood in stool, in severe cases may progress to sepsis	Domestic or wild animals are reservoirs. Exposure to ruminates faecal matter onto meat during processing	• Growth minimum 5.2°C, optimum 35-37°C, maximum 49.5°C. • Survive or slowly inactivated at freezing temperatures. Frozen storage near 0°C results in greater death or injury compared with -20°C. • Meat can be protective during freezing and frozen storage. • Growth inhibited at a_W < 0.94, survive well in a dry environment. Rate of death decreases as aw lowered and also decreases as temperature reduced. Optimum 0.99, • Inactivated at pH[4] < 3.8. Optimum 6.5-7.5. • Can grow in the presence or absence of oxygen (facultative anaerobe) • Sensitive to preservatives commonly used in foods. Growth inhibited by benzoic, sorbic and propionic acid. Inhibition enhanced with a combination of factors, e.g. preservative with reduction of pH and temperatures.	(Hara-Kudo and Takatori 2011, Eng et al. 2015)
Shiga toxin-producing *E. coli*	<50 to 200 cells	Acute gastroenteritis with or without blood in stool, in severe cases haemolytic uraemic syndrome or thrombotic thrombocytopaenia purpura develops	Ruminants are the animal reservoirs. Exposure to ruminates faecal matter onto meat during processing.	• Growth minimum 7-8°C, optimum 35-40°C, maximum 46°C. • Optimum growth in aerobic conditions • Can grow in vacuum-packed meat at 8°C and 9°C but not when meat packed under 100% CO_2. • Growth possible at a_w ≥ 0.95, some strains survive drying. • Growth possible at 6% NaCl, but not 8% • Acid tolerant, growth inhibited at pH[4] < 4.4 • Toxins not produced in foods.	(Molina et al. 2003, EFSA 2020)
L. monocytogenes	10^5-10^9 cells	Sub-acute gastroenteritis. In pregnancy can lead to serious/fatal foetus/new-born outcomes. Elderly and immunosuppressed may also present with severe systemic infection.	Wild and domesticated animals are reservoirs. Contamination of meat during processing.	• Growth minimum 1-5°C, optimum 30-37°C, maximum 45°C. • Survive or inactivated at freezing temperatures • Growth possible at a_W ≥ 0.9, survive a_W ≥ 0.83 • Growth possible at 12% NaCl • Growth inhibited at pH[4] < 4.6	(Quereda et al. 2021)
Campylobacter	350-800 cells	Acute gastroenteritis illness. Extraintestinal infections ore common in elderly, immunosuppressed and pregnant women.	Domestic, wild animals, birds and insects are common reservoirs of infection for humans.	• *C. jejuni/C. coli* thermotolerant but growth optimal at 42°C. No growth below 30.5°C and under refrigeration. Slow growing even under optimum conditions. • pH optimum 6.5 to 7.5. Growth in food inhibited at less than pH[4] 4.9. Rapid death occurs at pH <4	(Talibart et al. 2000).

Organism	Infectious dose [1]	Adverse foodborne health effects in humans	Contamination origin [2]	Characteristics [3]	References
			Cross contamination of meat during processing.	• Growth required reduced levels of oxygen (5-6%) and carbon dioxide (10%). • Sensitive to air, drying and heat. • Survival in food better under refrigeration than room temperature. • Freezing rate influence survival more than actual frozen storage but reduction can vary with the type of food and storage temperature. Slow freezing rates more lethal than rapid freezing due to osmotic stress. • Survives well in modified atmosphere and vacuum packing. • It can survive and even grow when initially packed under normal atmospheric conditions, as the metabolic activity of the food, such as raw meat may create a carbon-dioxide enhanced gaseous environment. • In adverse stress conditions, can enter viable but not culturable state.	
Y. enterocolitica	Insufficient data available	Acute gastroenteritis. Pseudo appendicitis syndrome in children possible.	Pigs are recognised reservoir but also found in other animals. Cross contamination of meat during processing.	• Temperature growth range -1.3 – 42°C. Optimum 28-29°C • Minimum pH[4] for growth ~4.1-5.1. Optimum 7.2-7.4 • Survives refrigeration and freezing. • Growth is inhibited under vacuum packing, 100%N_2 and CO_2/N_2 gas mixes, but effect more pronounced at refrigeration temperatures.	(Adams et al. 1991).
T. gondii	Not established. Animal studies indicate one sporulated oocyst was infective.	Varying depending on immune status. In most healthy individuals, infection is asymptomatic. Otherwise, viral like febrile illness can occur with swollen lymph nodes, rash and 'flu' like symptoms. May cause complications with pregnancies.	Cats are the definitive host. Oocysts shed by cats can infect humans and other mammals.	• Does not grow outside of suitable host. • Oocysts can survive in the environment. Remaining infective in water and faeces for months at 20-37°C • Sporulated oocysts (those containing sporozoites) killed by constant freezing at -21°C over 28 days, but not fluctuating temperatures between -21°C and room temperature. • Unsporulated oocysts are killed within 1 and 7 days of constant freezing at -21°C and -6°C, but not at -21°C • Cysts (bradyzoites) lose infectivity between -6°C and -40°C. Commercial freezing renders cysts non-infective at -9°C or colder.	(Frenkel and Dubey 1973, Kotula et al. 1991).

Abbreviations: a_w water activity.
Notes: [1] For all pathogenic bacteria and viruses, the infectious dose is not absolute – it is dependent on the pathogen strain, host immunocompetence and food matrix.
[2] Contamination origin: which reservoirs and contamination pathway for raw meat petfood occur.
[3] General characteristics of pathogen as taken from relevant risk profiles (Table 19), MPI hazard datasheets (https://www.mpi.govt.nz/science/food-safety-and-suitability-research/food-risk-assessment/foodborne-hazard-data-sheets/. Accessed 17 March 2023), (ICMSF 1996, Doyle and Beuchat 2007) or provided references. Excluding cooking parameters as it is not applicable for raw meat petfood.
[4] Minimum pH is influenced by other factors such as temperature, acid present and presence of salts and nitrate.

Table 19: Published risk profiles from New Zealand that are relevant to this discussion document

Pathogen	Meat product	Year of assessment	Findings	Reference
STEC	**Red meat and meat products** – skeletal muscular tissue and associated materials (fat and other tissues) from cattle, sheep, pigs, deer and young calves)	2014	• STEC detected (PCR) in meat from cattle, sheep and pigs in NZ, at up to 14.7% in one survey, but STEC with key virulence genes (*stx1* and/or *stx*2, *eae* and *hylA*) is low (less than 2%). • Low nubmers of STEC in red meats (<0.33 MPN/g) • Should exposure occur (consumption), the risk of infection from red meat would be high, as recent-dose response models predict that very low numbers of cells provide a high risk of infection. • Information from outbreaks and case-control studies have not provided evidence of human STEC infection via red meat in NZ.	(Rivas 2014)
C. jejuni/coli	**Red meat** – skeletal muscular tissue and associated materials from cattle, sheep and pigs.	2007	• NZ data for *C. jejuni/C. coli* in red meat was limited. • Numbers of *Campylobacter* on red meat at retail level are relatively low but consistent prevalence across pork, beef and sheep meat. • Red meats have not been identified as important risk factors in campylobacteriosis case-control studies in NZ.	(Lake et al. 2007a)
C. jejuni/coli	**Mammalian and poultry offals** – liver and kidneys	2007	• Prevalence of *Campylobacter* in offal is high in NZ (poultry liver up to 100% and sheep livers 38.9-66.9% while bovine and porcine offals <10%). • Offal considered a minor but definite transmission route (consumption) for campylobacteriosis in NZ.	(Lake et al. 2007b)
C. jejuni/coli	**Poultry** – whole and pieces	2013	• Quarterly NMD results for 2007-2012 reported *Campylobacter* prevalence ranging from 24.5 – 57% of carcasses tested at processing. • Study from suppliers or supermarkets of end of lay carcasses: 100% (n = 48), duck 97%, (73/75), turkey 83% (52/63) • Duck samples: 27 (20%, n = 135) – *Campylobacter* counts <2.3 $\log_{10}$ CFU per carcass). 16% of samples had counts exceeding 4.0 $\log_{10}$ CFU per carcass.	(Lake and Cressey 2013)
T. gondii	**Red meat and meat products:** skeletal muscular tissue and associated materials from cattle, sheep, pigs and deer and young calves (veal).	2015	• Insufficient data on prevalence of *T. gondii* in meat products in NZ • Burden of illness through these products is unknown. • Freezing inactivates *T. gondii* in meat products but time, temperature and type of meat all influences inactivation times.	(King and Perchec-Merien 2020)
Y. enterocolitica	**Pork**	2004	• Indications from outbreaks and case-control studies that pork is involved in transmission of a proportion of the yersiniosis cases in NZ, but prevalence for YE on pig carcasses and retail pork required to improve assessments.	(Lake et al. 2004)

Pathogen	Meat product	Year of assessment	Findings	Reference
Salmonella	**Poultry –** whole and pieces	2023	• Since 2011, *Salmonella* prevalence in NMD programme samples (a rinsate from a single carcass collected from the end of the primary processing chain from each processing plant on each processing day) has been very low (less than 1% on chicken carcasses and only two isolations in the previous four years). • *Salmonella* Enteritidis was isolated once (in 2021) from a chicken carcass during NMD programme testing. • Risk of human salmonellosis from poultry is low.	(Kingsbury 2023)

Abbreviations: Shiga-toxin producing *E. coli* (STEC); National microbiological database (NMD)

APPENDIX B: INFORMATION RETRIEVAL

B1. LITERATURE REVIEW

A Boolean search string was constructed including keywords used to define the scope of the review. This string was then used in PubMed:

10th November 2022:

(((((raw meat petfood) OR (raw meat based diets))) AND (food safety))

81 results, including 2 obtained with citation matching. 35 citations were relevant and selected.

The same search terms were also used in Web of Science. 25 citations were relevant and selected.

The two lists of articles were combined, and duplicates were removed, resulting in 37 articles. These formed the basis of literature search. As it was likely that initial searches missed important references, reference lists of articles were also checked for additional reference covering key topics and included where appropriate.

B2. SNAPSHOT OF COMMERCIAL RAW MEAT PRODUCTS IN NEW ZEALAND

In March 2023, commercial raw meat products available in New Zealand were collated using online searches. This involved using terms such as ‘raw petfood’, ‘raw meat petfood’, ‘raw dog food’ and ‘raw cat food’ and consulting websites for manufacturers/suppliers, pet and petfood speciality store and supermarket websites for relevant products.

In addition, each processor listed under the MPI further (petfood) processors[67] was searched online for additional relevant products. At the time of the search, forty-four of the listed processors were either not relevant for raw meat petfood (i.e., only made dry dog food treats) or did not have any or limited information available online. For many companies, products included ingredient lists but some did not, those in the latter were not included in Table 3.

B3. GREY LITERATURE SEARCH

Additional searches predominantly involved grey literature sources and were heavily informed by information gathered from overseas regulatory agencies. Sources included:

Border rejections, recalls, alerts:

New Zealand food recalls and complaints.

https://www.mpi.govt.nz/food-safety-home/food-recalls-and-complaints/recalled-food-products/

[67] https://www.foodsafety.govt.nz/registers-lists/further-petfood-processors.htm?setup_file=further-petfood-processors.setup.cgi&rows_to_return=20000&submit_search=Search Accessed 22 March 2023.

European Rapid Alert System for Food and Feed (RASSF)
https://ec.europa.eu/food/food/rasff-food-and-feed-safety-alerts_en

US FDA import refusal report:
https://www.accessdata.fda.gov/scripts/ImportRefusals/index.cfm

US FDA recalls, market withdrawals and public health alerts.
https://www.fsis.usda.gov/recalls

US FDA annual recall summaries:
https://www.fsis.usda.gov/food-safety/recalls-public-health-alerts/annual-recall-summaries

Health Canada, Recalls and safety alerts:
https://recalls-rappels.canada.ca/en

Australian border rejections
https://www.awe.gov.au/biosecurity-trade/import/goods/food/inspection-testing/failing-food-reports

Regulatory documents:

Codex standards
https://www.fao.org/fao-who-codexalimentarius/codex-texts/list-standards/en/

Code of Federal Regulation
https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=556

European Commission standards
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31990R2377

Australia and New Zealand standards
https://www.foodstandards.gov.au/code/Pages/default.aspx

In addition, regulatory and other raw meat petfood information was also search for within petfood association websites (Table 20).

Unless specified within the text regarding searches, the websites listed above were access between January – June 2023.

Table 20: Selected petfood associations and groups in various countries

Name	Country based	Purpose	Audience	Website	Petfood manufacturing guidelines?
New Zealand Petfood Manufacturers Association (NZPFMA)	New Zealand	Non-profit association that supports petfood manufacturing in NZ.	Members are petfood manufacturers and companies supplying to manufacturers.	www.petfood.nz	Yes – available for members only.
Petfood Industry Associations Australia	Australia	Association promoting standards of excellence in the development of petfood industry. Works with the regulators to influence the development of standards.	Members are petfood manufacturers, marketers and affiliated industry members.	www.pfiaa.com.au	Yes – All members must meet standards - AS5812-2017 Manufacturing and marketing of petfood and PISC 88 – Standard for hygienic production of Pet meat.
Global Alliance of Petfood Associations	Belgium	Non-profit association. Provides a forum to address industry consensus on key issues including food safety.	Members represent national and regional petfood industry associations and three companies of petfood manufacturers.	www.gapfa.org	Not identified online. Possibly within member information.
American Pet Products Association	United States of America (US)	Trade association that promotes responsible pet care and helps to advance the petfood industry.	Members are petfood manufacturers, their representatives, importers and livestock suppliers.	www.americanpetfoodprroducts.org	Not identified online – Possibly within member information. Government affairs Group within the association that helps advise members of regulatory requirements.
Petfood Institute	US	Advocates for legalisation, regulations and technologies that support domestic manufacture and global distribution Provides petfood safety innovation.	Members are petfood and pet treat manufacturers.	www.petfoodinstitute.org	Not identified online.
Association of American Feed Control Officials	US	Private organisation. Development of law and regulations (not enforceable). Forum to foster collaboration between control officials, industry association and consumer groups.	Members are all state and federal officials	www.affco.org	Yes - Guidance for industry document available online.

Name	Country based	Purpose	Audience	Website	Petfood manufacturing guidelines?
Petfood Association of Canada (PFAC)	Canada	Association that provides members with regulatory support, government relations, export and market access and other services.	Represents petfood manufacturers and those that supply ingredients, products and services.	www.pfac.com	Requirement of membership that member follow a recognised food safety program. As many companies export to the US, they have to meet US regulations and manufacturers are audited.
European Petfood Industry Federation Fédération Européenne de l'Industrie des Aliments pour Animaux Familiers (FEDIAF)	Belgium	Trade body that represents the European petfood industry.	National trade associations[1] and petfood manufacturers.	www.europeanpetfood.org	Members require adoption of an internal set of standards. Guide for the Good Practice for the Manufacturer of Safe Petfood[2].
United Kingdom (UK) Petfood	UK	Association which supports petfood manufacturing. Advocate of raising standards and providing education information on pet nutrition and manufacture of petfood.	Members are petfood manufacturers, suppliers and wider industry.	www.ukpetfood.org	Yes – Guidelines for the manufacture of raw petfood in the UK freely available online.
RawSAFE	UK	Independent audit of manufacturer to obtain a legally protected Certification Mark of assurance that the brand is manufactured to the highest standard. • RawSAFE™ company is part owned by the Raw Feeding Veterinary Society	Petfood manufacturers	www.rawsafe.com www.rfvs.info/rawsafe	Not identified online. Possibly within member information.

Notes:

[1] Includes petfood associations from Austria, Belgium, Czech Republic, Nordic (Denmark, Finland, Norway, Sweden), France, Germany, Hungary, Ireland, Italy, Poland, Romania, Spain, Switzerland, United Kingdom. (All websites accessed 23 February 2023)

[2](The European Pet Food Industry 2018)

APPENDIX C: ADDITIONAL INFORMATION FOR IMPORTS, NOTIFICATIONS, BORDER REJECTIONS AND RECALLS

Table 21: Import consignments for kangaroo meat and other meat intended for petfood recorded by MPI between January 2020 – February 2023

Arrival date	Product class	Product subclass	Units[1]	Consignment description
KANGAROO MEAT				
3/01/2020	Animal Foods	Animal Foods	18044.34	Frozen kangaroo meat
10/02/2020	Animal Foods	Animal Foods	18055.98	Kangaroo meat - frozen for petfood
28/02/2020	Animal Foods	Animal Foods	14656	Frozen wild game kangaroo meat for petfood only
26/03/2020	Animal Foods	Animal Foods	14731	Frozen wild kangaroo meat
17/04/2020	Animal Foods	Animal Foods	14447	Frozen wild kangaroo meat
8/06/2020	Meat Products	Meat Products	14190	Frozen wild kangaroo meat
26/06/2020	Animal Foods	Animal Foods	17886.45	Frozen kangaroo meat for pet
28/06/2020	Animal Foods	Animal Foods	7998	Kangaroo meat
23/08/2020	Animal Foods	Animal Foods	18014	Frozen wild kangaroo meat
27/08/2020	Meat Products	Meat Products	76	Kangaroo meat
31/08/2020	Animal Foods	Animal Foods	18006	Frozen kangaroo
18/10/2020	Meat Products	Meat Products	17737.7	Kangaroo meat
26/10/2020	Meat Products	Meat Products	18009.09	Frozen wild kangaroo meat
12/11/2020	Animal Foods	Animal Foods	0.5	Frozen kangaroo tendon
4/12/2020	Animal Foods	Animal Foods	17975	Kangaroo meat
25/12/2020	Meat Products	Meat Products	12018	Kangaroo meat
1/01/2021	Meat Products	Meat Products	15031.76	Frozen kangaroo meat
16/01/2021	Animal Foods	Animal Foods	11560	Kangaroo meat and samples
20/02/2021	Animal Foods	Animal Foods	16400	Frozen wild kangaroo meat
7/03/2021	Animal Foods	Animal Foods	0.01	Kangaroo cuts petfood
1/04/2021	Meat Products	Meat Products	16223.19	Kangaroo meat
29/04/2021	Meat Products	Meat Products	15987.08	Kangaroo meat for petfood
21/06/2021	Animal Foods	Animal Foods	16008.14	Frozen - boneless Kangaroo
13/07/2021	Animal Foods	Animal Foods	0.5	Frozen kangaroo tendon
12/09/2021	Animal Foods	Animal Foods	14101	Frozen kangaroo meat
26/10/2021	Animal Foods	Animal Foods	14508	Frozen wild kangaroo meat
26/10/2021	Animal Foods	Animal Foods	9120	Kangaroo meat - boneless
26/10/2021	Animal Foods	Animal Foods	850	Kangaroo meat and bone meal
28/11/2021	Meat Products	Meat Products	63.33	Frozen wild game kangaroo.
9/12/2021	Animal Foods	Petfood	23509.98	8 pallets and 791 cartons of frozen kangaroo meat for animal consumption
23/01/2022	Animal Foods	Petfood	15387.62	6 pallets & 490 cartons of frozen meat for animal consumption
13/02/2022	Meat Products	Meat Products	37.01	Frozen kangaroo meat
14/04/2022	Meat Products	Meat Products	17873.6	Frozen wild kangaroo
17/06/2022	Meat Products	Meat Products	113.83	Frozen kangaroo meat
4/07/2022	Meat Products	Meat Products	14707	Frozen kangaroo meat for petfood only
27/08/2022	Meat Products	Meat Products	1254.47	Frozen kangaroo meat – 1kg
0/09/2022	Meat Products	Meat Products	23469	Frozen wild kangaroo meat - petfood

Arrival date	Product class	Product subclass	Units[1]	Consignment description
23/09/2022	Animal Foods	Animal Foods	9600	Frozen kangaroo meat
29/09/2022	Meat Products	Meat Products	23546	Frozen Kangaroo meat
7/10/2022	Meat Products	Meat Products	56.84	Chilled kangaroo meat
8/11/2022	Animal Foods	Animal Foods	14400	Frozen kangaroo meat
13/11/2022	Animal Foods	Animal Foods	10080	Petfood from kangaroo
16/11/2022	Meat Products	Meat Products	4	Chilled kangaroo meat
1/12/2022	Meat Products	Meat Products	10000	Kangaroo
9/12/2022	Animal Foods	Animal Foods	14181	Frozen wild kangaroo - petfood only
29/12/2022	Animal Foods	Animal Foods	14757	Frozen kangaroo meat
OTHER MEAT IMPORTED FOR PETFOOD				
26/01/2021	Animal Foods	Petfood	22797.9	Frozen bone in lamb (raw)
18/11/2021	Animal Foods	Petfood	24940	Frozen Lamb for animal consumption
4/12/2021	Animal Foods	Animal Feed	23249.98	Frozen lamb for animal consumption
23/12/2021	Animal Foods	Animal Feed	25000	Frozen bone in lamb
15/02/2022	Animal Foods	Petfood	17318	Frozen pork hearts
24/02/2022	Animal Foods	Petfood	24000	Frozen bone in lamb
8/03/2022	Animal Foods	Petfood	25000	Frozen lamb cuts
23/09/2022	Animal Foods	Petfood	25000	Frozen bone in lamb

Notes: [1] Consignment weights are requested on the MPI import form, but values observed in entries can be inconsistent. Values within the table may therefore not accurately reflect the total weight of a consignment.

Table 22: The United States Food and Drug Association border refusals of petfood and related products relating to the presence of *Salmonella* between 2014 and 2022[1]

Country of origin	Date of refusal	Product description
New Zealand	15/07/2022	PET DOG FOOD N.E.C.
Mexico	5/11/2021	MEAT (MAMMALIAN MUSCLE) PROD PET DOG FOOD
Brazil	10/06/2021	COMB PROD PET DOG FOOD
Brazil	10/06/2021	COMB PROD PET DOG FOOD
Nepal	30/01/2020	PET DOG FOOD N.E.C.
Australia	4/12/2018	OTHER PETFOOD, N.E.C.
China	30/07/2018	PET DOG FOOD N.E.C.
Canada	30/04/2018	POULTRY PROD PET DOG FOOD
Canada	25/04/2018	COMB PROD PET DOG FOOD
Vietnam	11/10/2017	PET DOG FOOD N.E.C.
Vietnam	11/10/2017	PET DOG FOOD N.E.C.
Vietnam	11/10/2017	PET DOG FOOD N.E.C.
Vietnam	11/10/2017	PET DOG FOOD N.E.C.
Vietnam	11/10/2017	PET DOG FOOD N.E.C.
Vietnam	11/08/2017	PET DOG FOOD N.E.C.
Canada	15/06/2017	PET DOG FOOD N.E.C.
Canada	25/05/2017	PET DOG FOOD N.E.C.
China	25/05/2017	PET DOG FOOD N.E.C.
Canada	15/05/2017	COMB PROD PET DOG FOOD
China	9/05/2017	OTHER PETFOOD, N.E.C.
China	9/05/2017	PET DOG FOOD N.E.C.
Canada	31/03/2017	PET DOG FOOD N.E.C.
Canada	31/03/2017	PET DOG FOOD N.E.C.
Canada	31/03/2017	PET DOG FOOD N.E.C.
Canada	31/03/2017	PET DOG FOOD N.E.C.
Canada	23/03/2017	PET DOG FOOD N.E.C.
Canada	23/03/2017	PET DOG FOOD N.E.C.
Canada	23/03/2017	PET DOG FOOD N.E.C.
Canada	23/03/2017	PET DOG FOOD N.E.C.
Canada	23/03/2017	PET DOG FOOD N.E.C.
Canada	17/03/2017	PET DOG FOOD N.E.C.
Canada	17/03/2017	PET DOG FOOD N.E.C.
Canada	17/03/2017	PET DOG FOOD N.E.C.
Canada	17/03/2017	PET DOG FOOD N.E.C.
Canada	17/03/2017	PET DOG FOOD N.E.C.
Canada	17/03/2017	PET DOG FOOD N.E.C.
Canada	16/03/2017	PET DOG FOOD N.E.C.

Country of origin	Date of refusal	Product description
Germany	13/09/2016	MEAT (MAMMALIAN MUSCLE) PROD PET DOG FOOD
Germany	13/09/2016	MEAT (MAMMALIAN MUSCLE) PROD PET DOG FOOD
Canada	7/03/2016	COMB PROD PET DOG FOOD
Argentina	2/12/2015	PET DOG FOOD N.E.C.
Australia	12/08/2015	PET DOG FOOD N.E.C.
Australia	14/08/2014	MEAT (MAMMALIAN MUSCLE) PROD PET DOG FOOD
Bangladesh	28/07/2014	MEAT (MAMMALIAN MUSCLE) PROD PET DOG FOOD
Mexico	17/07/2014	PET DOG FOOD N.E.C.
China	26/06/2014	OTHER PETFOOD, N.E.C.
Mexico	20/06/2014	OTHER PETFOOD, N.E.C.
Bangladesh	7/04/2014	MEAT (MAMMALIAN MUSCLE) PROD PET DOG FOOD
Australia	6/03/2014	PET DOG FOOD N.E.C.

Abbreviations: N.E.C = Not elsewhere classified. PROD = Product. COMB: combination.
Notes: [1]All records are available on the US FDA website: https://www.accessdata.fda.gov/scripts/ImportRefusals/index.cfm (Accessed 3 April 2023)

Table 23: Reported United States Food and Drug Association and Health Canada recalls/cautions of petfood relating to the presence of microbial hazards 2018 – 2023[1]

Date	Company	Product	Pathogen	Country (and distribution). Details	Human/animal illness linked
Dec-22	TFP Nutrition	Dry food - cat	*Salmonella*	US (Texas). Voluntary recall	No
Sep-22	Spot and Tango	UnKibble Dog food	*Salmonella*	US (not stated). Voluntary recall	No
Aug-22	**Darwin's**	**Raw meat cat food**	***Salmonella* Typhimurium and *Salmonella* Kentucky**	**US (not stated). Caution only.**	**Yes: Animal illness of three kittens. No human cases.** https://www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-cautions-pet-owners-not-feed-certain-lots-darwins-natural-pet-products-due-salmonella#:~:text=The%20U.S.%20Food%20and%20Drug,kittens%20in%20a%20single%20household.(Accessed 7 June 2023)
Jul-22	Stormberg Foods	Chicken strips/breast dog treats	*Salmonella*	US (nationwide). Voluntary recall	No
Jul-22	**Primal Petfood**	**Raw beef (frozen)**	***Listeria monocytogenes***	**US (3 US states and British Columbia, Canada). Voluntary recall**	**No**
Jun-22	FreshPet	Freshpet Select Fresh from the Kitchen Home Cooked Chicken	*Salmonella*	US (13 US states). Voluntary recall	No
Feb-22	Family Dollar Inc.	Dog and cat food and treats (multiple other products)	*Salmonella*	US (not stated). Voluntary recall	No
Feb-22	Dog Gone Dog Treats	Beef liver chips	*Salmonella*	US (~7 US states). Voluntary recall	**Yes: Human illness, 2 adults, one child[4].** https://www.petfoodindustry.com/articles/11050-dog-gone-dog-treats-recalled-for-salmonella (Accessed 4 April 2023)
Dec-21	Woody's Petfood Deli	Raw Cornish Hen petfood "With Supplements"	*Salmonella*	US (2 US states). Voluntary recall	No
Aug-21	**Top Quality Dog Food**	**Ground raw meat and vegetables**	***Salmonella* and *L. monocytogenes***	**US (8 US states). Voluntary recall**	**No**
Jun-21	Manna Pro Products LLC	Dry food	*Salmonella*	US (nationwide). Voluntary recall	Not stated.
Jun-21	Freshpet Inc.	Dry food - 'Select Small Dog Bite Size Beef & Egg Recipe Dog Food'	*Salmonella*	US (~5 US states). Voluntary recall	No
Jun-21	Fleet Wholesale Supply Co./Sunshine Mills	Formula' food	*Salmonella*	US (~17 states). Voluntary recall	No
May-21	Natural Balance Petfood Inc	Dry food - 'Pea & Chicken Formula'	*Salmonella*	US (nationwide) and Canada. Voluntary recall	No
Apr-21	J. M. Smucker Co.	Dry cat food	*Salmonella*	US (8 US states). Voluntary recall	No
Mar-21	Midwestern Petfood	Petfood (multiple brands)	*Salmonella*	US (nationwide) and 19 other countries. Voluntary recall	No

Date	Company	Product	Pathogen	Country (and distribution). Details	Human/animal illness linked
Mar-21	**Bravo Packing Inc.**	**Raw meat (frozen)**	***Salmonella* and *L. monocytogenes***	**US (nationwide). Voluntary recall**	**No**
Nov-20	**Albright's**	**Raw meat (frozen)**	***Salmonella***	**US (10 US states). Voluntary recall**	**Yes: One animal illness. No human cases.** https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/albrights-raw-dog-food-recalls-chicken-recipe-dogs-because-possible-salmonella-health-risk#:~:text=The%20product%20is%20labeled%20Albright's,to%208%2F27%2F20. (Accessed 7 June 2023)
Oct-20	Billy + Margot	Dry food	*Salmonella*	US (nationwide). Voluntary recall	No
Sep-20	Masters Best Friend	Pig ear chews	*Salmonella* Typhimurium	Canada (nationwide)	**Yes: Ten human cases. Three hospitalised. One death[4].** https://www.canada.ca/en/public-health/services/public-health-notices/2020/outbreak-salmonella-illnesses-dog-treats.html (Accessed 4 April 2023)
Jun-20	**Carnivora**	**Raw meat (frozen)**	**STEC O157**	**Canada (4 provinces but potentially nationwide). Consumer level recall.**	**Yes: Five human cases.** https://www.canada.ca/en/public-health/services/public-health-notices/2020/outbreak-e-coli-frozen-raw-pet-food.html (Accessed 7 June 2023)
Aug-19	**Aunt Jeni's**	**Raw petfood (frozen)**	***Salmonella* Infantis and *L. monocytogenes***	**US (not stated). Caution only.**	**Not stated**
Nov-19	Go Raw	Beef cat food	*Salmonella*	US (not stated). Voluntary recall	No
Sep-19	**Performance Dog (Bravo Packaging Inc)**	**Raw petfood (frozen)**	***Salmonella* and *L. monocytogenes***	**US (not stated). Caution only**	**Not stated**
Sep-19	TDBBS	Pig ear chews	*Salmonella*	**US (not stated). Voluntary recall**	No
Aug-19	Dog Goods	Pig ear chews	*Salmonella*	US (not stated). Expanded voluntary recall	Not stated
Aug-19	Brutus and Barnaby	Pig ear chews	*Salmonella*	US (nationwide). Sourced from Columbia. Voluntary recall	No
Aug-19	**Texas Tripe Inc.**	**Raw petfood (frozen)**	***Salmonella* and *L. monocytogenes***	**US (24 US states). Caution only**	**Not stated**
Jul-19	Lennox Intl	Pig ear chews (imported from Brazil & Argentina)	*Salmonella* Infantis, London, Newport	US (nationwide). Sourced from South America. Expanded voluntary recall	**Yes: 154 human cases[4].** https://www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-investigates-contaminated-pig-ear-pet-treats-connected-human-salmonella-infections. (Accessed 7 June 2023)
Jul-19	Pet Supplies Plus	Pig ear chews	*Salmonella*		Unknown
Apr-19	**Thogersen Family Farm**	**Raw petfood (rabbit, mallard duck, llama and pork)**	***L. monocytogenes***	**US (not stated). Voluntary recall**	**No**

Date	Company	Product	Pathogen	Country (and distribution). Details	Human/animal illness linked
Mar-19	**Darwin's Natural Pet Products** [2]	**Raw petfood (frozen)**	***Salmonella***	**US (not stated). Caution only.**	**No**
Jan-19	**Woody's Petfood Deli**	**Raw turkey petfood**	***Salmonella* Reading**	**US (not stated). Voluntary recall**	**Yes: Linked with outbreak involving raw turkey: 358 human cases** https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 7June 2023)
Jan-19	Hare Today Gone Tomorrow	Ground chicken/bones/organs	*Salmonella* and *Listeria*	US (not stated). Caution only	No
Dec-18	**Columbia River Natural Petfood**	**Raw petfood**	***Salmonella* and *L. monocytogenes***	**US (not stated). Voluntary recall**	**No**
Oct-18	**G&C Raw**	**Raw dog and cat food**	***L. monocytogenes***	**US (10 US states). Voluntary recall**	**No**
Sep-18	**Radagast Pet Food Inc.**	**Raw petfood**	***L. monocytogenes***	**Canada (manufactured in US). Consumer level recall**	**No**
Sep-18	**Performance Dog (Bravo Packing Inc)**	**Raw petfood**	***Salmonella***	**US (nationwide). Voluntary recall**	**No**
Sep-18	Steve's Real Food	Petfood	*Salmonella* and *Listeria*	US (nationwide). Voluntary recall	No
Aug-18	G&C Raw	Ground turkey cat food and ground lamb dog food	*Listeria monocytogenes*	US (10 US states). Voluntary recall	No
Jul-18	**Radagast Pet Food Inc.**	**Raw pet food**	***L. monocytogenes***	**Western Canada (manufactured in US). Consumer level recall.**	**No**
Apr-18	**OC Raw Dog**	**Raw dog food**	***L. monocytogenes***	**US (7 US states). Voluntary recall**	**No**
Apr-18	TruDog	Freeze-dried dog food	*Salmonella*	US (nationwide). Voluntary recall	No
Feb-April 2018	Carnivore Meat Company	Freeze-dried dog food	*Salmonella*	US (nationwide). Voluntary recall	No
Apr-18	K9 Natural	Dog food (NZ cage free chicken - imported)	*Listeria monocytogenes*	US (~5 US states) and Canada. Imported.	No
Mar-18	**Blue Ridge Beef**	**Raw petfood**	***Salmonella* and *L. monocytogenes***	**US (5 US states). Voluntary recall**	**No**
Mar-18	**Raw Basics**	**Raw pork-bison dog food**	***Salmonella***	**US (4 US states). Voluntary recall**	**No**
Mar-18	**Steve's Real Food**	**Raw dog food**	***Salmonella***	**US (21 US states). Voluntary recall**	**No**
Feb-18	**Northwest Naturals**	**Raw dog food**	***L. monocytogenes***	**US (6 US states). Voluntary recall**	**Not stated**

Date	Company	Product	Pathogen	Country (and distribution). Details	Human/animal illness linked
Feb-18	TruPet	Pet treats	*Salmonella*	US (nationwide). Voluntary recall	No
Feb-18	Smokehouse Pet Products	Beef muchies - treats	*Salmonella*	US (~4 US states). Expanded voluntary recall	No
Feb-18	**Christofersen Meats Company, Swanson Meats/Raw for Paws**	**Raw meat**	***Salmonella* Reading**	**US (not stated). Voluntary recall**	**Yes: Linked with outbreak involving raw turkey: 358 human cases .** https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 7June 2023)
Feb-March 18	Redbarn Pet Products	Dog chews - bully sticks	*Salmonella*	US (not stated). Expanded voluntary recall	No
Feb-18	**Christofersen Meats Company, Swanson Meats/Raw for Paws**	**Raw meat**	***Salmonella* Reading**	**US (not stated). Voluntary recall**	**Yes: Linked with outbreak involving raw turkey: 358 human cases.** https://www.cdc.gov/salmonella/reading-07-18/index.html (Accessed 7June 2023)
Jan-18	Just Food for Dogs	Dog food	*L. monocytogenes*	US (California). Voluntary recall	No confirmed animal cases but dogs reported with short term symptoms. No human cases
Oct-16 Feb-18[2]	**Darwin's Natural Pet Products**	**Raw petfood**	***Salmonella* and/or, *L. monocytogenes*, STEC O128,**	**US (not stated). Multiple voluntary recalls.**	**Yes: Animal illness linked to pet food. Also linked with *Salmonella infantis* outbreak involving raw chicken: 129 human cases.** https://public4.pagefreezer.com/browse/FDA/03-05-2022T01:45/https://www.fda.gov/animal-veterinary/news-events/updated-fda-investigates-pattern-contamination-certain-raw-pet-foods-made-arrow-reliance-inc. (Accessed 8 June 2023) https://www.cdc.gov/salmonella/infantis-10-18/index.html (Accessed 7 June 2023)

Abbreviations: United States of America (US), Shiga toxin-producing *E. coli* (STEC).
Notes:[1]Data was extracted from the United States Food and Drug, Association Recalls, Market Withdrawals and Safety Alerts Website: https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts and Health Canada recalls, advisories and safety alerts (https://recalls-rappels.canada.ca/en) (Accessed 7 June 2023). Entries in **bold** are those listing raw meat petfood.
[2] Five recalls noted for this company between October 2016 and February 2018.
[3] Those entries with human illness cases involving raw meat petfood linked to outbreaks are described in Table 8.
[4] Further information outlined in Appendix D1.

APPENDIX D: SUPPLEMENTARY OUTBREAK INFORMATION

D1. OTHER REPORTED PETFOOD OUTBREAKS

Other historic outbreaks of commercially **dry petfood and treats** in the US and Canada as follows:

- In 2019, 154 human cases of *Salmonella* serotypes I, 4[5}, 12:i:-, Cerro, Derby, Infantis, London, Newport and Rissen was reported across multiple states within the US. Thirty-five cases were hospitalised, and 27 cases were children younger than 5 years old. Testing found that some of the strains were antibiotic resistant. Exposure to pig ear pet treats was common among cases and tracebacks found some treats were from Argentina, Brazil and Colombia and product testing confirmed the presence of *Salmonella* serotypes London, Typhimurium, Newport and Infantis.[68] Pigs ears did not account for all of the illnesses in the outbreak. Effective product irradiation may not have occurred for bulk products or for packaged individual wrapped products.
- In 2012, outbreak of *Salmonella* Infantis involving 53 human cases across US and Canada was reported with 38% (n = 20) of cases identified as children ≤2 years old. Investigations identified a dry dog food brand, and the outbreak strain was isolated from bags of dry dog food and faecal specimens from dogs that lived with ill people and that ate the implicated dry dog food. Thirty-one ill dogs were also linked to this outbreak and a recall was issued (Centers for Disease Control 2012, Imanishi et al. 2014).
- During 2004-2005, contact with *Salmonella*-contaminated pet treats of beef and seafood origin resulted in non-culture-confirmed human *Salmonella* Thompson infections in Canada and in the US. Although raw ingredients used in the petfood were dehydrated the temperatures were not high enough to kill bacteria that might have been present. No processing step was performed (Centers for Disease Control 2006, Health Canada 2006).
- An outbreak of *Salmonella* Schwarzengrund attributed to dry petfood from a single manufacturer occurred over a three-year period (2006-2009). Seventy-nine cases in the US were confirmed. Similar genetically related isolates obtained from human cases and petfood and within the manufacturer of the petfood. Mostly young children infected and feeding pet in the kitchen in univariable case-control study found as a risk factor (Centers for Disease Control 2008, Behravesh et al. 2010).
- In 2002, contaminated pet treats manufactured in the US (Texas) were associated with human *Salmonella* Newport infections in Canada (Pitout et al. 2003).
- In 1999, contaminated pig ear pet treats were confirmed as the source of an outbreak of human *Salmonella* Infantis infections in several Canadian provinces (Clark et al. 2001).

[68] https://www.fda.gov/animal-veterinary/outbreaks-and-advisories/fda-investigates-contaminated-pig-ear-pet-treats-connected-human-salmonella-infections (Accessed 4 April 2023).

APPENDIX E: LEGISLATION AND CODES

E1. CURRENT LEGISLATION AND CODES

The Animal Welfare Act 1999

The Animal Welfare Act 1999[69] defines the fundamental obligations for how people should care for and act towards animals. The Animal Welfare (commercial slaughter) code of welfare 2016 is particularly relevant for primary petfood processors and outlines requirements for animal holding facilities, restraints and slaughtering and processing of animals (Ministry for Primary Industries 2018a).

Agricultural Compound and Veterinary Medicines Act 1997

The purpose of the Agricultural Compound and Veterinary Medicines (ACVM) Act 1997[70] is to prevent or manage risks associated with the use of agricultural compounds. In New Zealand, all animal feeds, including petfood, nutritional supplements and milled feeds are subject to regulation under ACVM Act 1997 as "oral nutritional compounds".

Petfoods are considered as oral nutritional compounds under the ACVM legislation but are normally exempt from registration as they do not pose much risk.[71, 72] However, petfoods are not unless their label has a therapeutic claim. Therapeutic label claims increase the ACVM risk, especially to animal welfare and must go through the veterinary registration process to prove the claim is accurate. However, all petfood must still meet the requirements for oral nutritional compounds as set out in ACVM regulations.

The Animal Products Act 1999

The Animal Products Act (APA) 1999 regulates the processing of animal material into products for use, trade, and export through managing associated risks and facilitating overseas market access.[73] If a petfood contains animal material, then processors are required to also meet the requirements for the APA. The Act requires all animal products traded and used to be "fit for intended purpose".

Animal products regulations 2021

The new redesigned animal product regulation 2021 was published and came into force on the 1 July 2022. This redesigned regulation was the result of consolidating and simplifying

[69] https://www.legislation.govt.nz/act/public/1999/0142/latest/DLM49664.html (Accessed 13 January 2023)
[70] https://www.legislation.govt.nz/act/public/1997/0087/latest/whole.html (Accessed 23 March 2023)
[71] https://www.mpi.govt.nz/agriculture/agricultural-compounds-vet-medicines/acvms-exempt-from-registration/#examples (Accessed 23 March 2023)
[72] Agricultural Compounds and Veterinary Medicines (Exemptions and Prohibited Substances) Regulations 2011 (SR 2011/327) (as at 18 July 2022) – New Zealand Legislation (Accessed 7 March 2023)
[73] https://www.legislation.govt.nz/act/public/1999/0093/latest/DLM33502.html (Accessed 13 January 2023)

five animal products regulations and one Order in Council.[74] The Regulations set out animal product standards and provides the setting of specification for processors.

The Animal Products Notice: Production, Supply and Processing is issued under the APA and supplements the Animal Product Amendment Regulations 2022 in relation to the production, supply and processing of animal materials and animal products, verification and recognised agencies and persons (Ministry for Primary Industries 2022b, a).

Petfood Processing Operational Code

The Petfood Processing Operational Code (Code) was developed by MPI in consultation with the NZPFMA (Ministry for Primary Industries 2018b). The Code provides guidance to operators that are involved in the primary and secondary processing of petfood and the transport of animal material or product for processing to petfood, in order to comply with the requirements of the APA and any other relevant legislations.

The Code also provides recommendations for “further (petfood) processors” for good operating practices, despite these operators not requiring documentation and implementation of an RMP.

In addition, a training booklet was also developed to provide guidance and information to support information within the Code (New Zealand Pet Food Manufacturers Association and New Zealand Food Safety Ministry for Primary Industries 2013).

E2. MANDATORY REQUIREMENTS

Risk Management Programmes

The APA[75] defines an RMP as a programme designed to identify and control, manage, and eliminate or minimise hazards and other risk factors in relation to the production and processing of animal material and animal products in order to ensure that the resulting animal product is fit for intended purpose. The RMP is based on the principles of Hazard Analysis and Critical Control Points (HACCP), which identifies hazards, the systems of control and demonstrating that the controls are effective (Ministry for Primary Industries 2022c).The Act requires that RMPs are tailored for each animal product business according to the animal materials used, the processes performed, and the product range produced. Operators must build any relevant regulatory limits (for example microbiological limits) into their RMP but can also set their own measurable limits (operator defined limits) to ensure the food is safe and fit for purpose.

[74] https://www.mpi.govt.nz/legal/legislation-standards-and-reviews/redesign-of-animal-products-and-wine-regulations-and-notices/ (Accessed 23 March 2023)
[75] https://www.legislation.govt.nz/act/public/1999/0093/latest/whole.html (Accessed 13 January 2023)