THE STATUS OF NEW ZEALAND'S FOOD

Report on the NZFSA-ESR Science Contract 2005-2006

Prepared as part of a New Zealand Food Safety Authority contract for scientific services

January 2007

Institute of Environmental Science & Research Limited
Christchurch Science Centre
Location address: 27 Creyke Road, Ilam, Christchurch
Postal address: P O Box 29 181, Christchurch, New Zealand
Website: www.esr.cri.nz

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Client Report
FW0680

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Stephen On
Food Safety Programme Manager

Peter Cressey
Project Leader and Editor

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PREFACE

The ESR mission statement "protecting people and their environment through science" is arguably no better reflected than in the partnership between the New Zealand Food Safety Authority (NZFSA) and the ESR Food Safety Programme. "You are what you eat": ergo, public health and food safety are inexorably related. The services and projects undertaken by ESR for the NZFSA are geared to deliver information that informs and protects public health. As such, we at ESR regard this body of work as a priority issue and pride ourselves on delivering high-quality results that enable fellow professionals at the NZFSA to serve public health.

The success of the NZFSA-ESR partnership is more than adequately illustrated by the New Zealand Total Diet Survey (NZTDS), a substantive project conducted approximately every five years to determine trends in chemical and nutritional components of the New Zealand diet. A variety of foodstuffs (121 in total) are prepared as they would be in the average New Zealand household and their content analysed. The middle of 2005 saw the collation and publication of the most recent study, to substantial acclaim and media interest. Of particular significance were the findings that dietary salt intake was in excess of healthy limits, while in contrast iodine intake was significantly lower that recommended. The link between high salt consumption with elevated blood pressure and hence heart disorders, and iodine deficiency with thyroid dysfunction (that in extreme cases manifests as goitre, a gross swelling of the gland that distends the throat) illustrates the importance of the study for New Zealand consumers.

Allergic reactions to food components can be life-threatening and there is evidence for an increasing number of people become sensitised. NZFSA recognises the need for capability in diagnostic assays in this area and ESR has now developed a substantive capability, such that all common food allergens can be assayed for. During this year, validation of assays for peanut and sesame seed contaminants was successfully undertaken, adding to the extant assays for eight other allergens and enabling effective response to such issues as and when they may arise.

We continue to operate within a risk management framework in which our risk profiling and risk ranking activities are essential components. This past year has seen delivery of a number of risk profiles covering topics of significant interest, including *Clostridium botulinum* in both honey and seafood, shiga-toxin producing *E. coli* in salad vegetables and uncooked, comminuted fermented meat (UCFM) products, and enteropathogenic *Campylobacter* spp. in offal, red meat and poultry. A substantive review of transmission routes for human campylobacteriosis in New Zealand was also finalised and concluded that poultry was the major, but not only, reservoir of infection. This is in general agreement with international opinion and experience. The increasing incidence of *Campylobacter* enteritis in New Zealand attracted considerable media attention during 2006 and subsequent work has been significantly informed by the data in these reports, as well as other projects on viability and transfer of bacteria during domestic handling practices.

Determining the risk to public health from foodborne pathogens demands access to effective detection or isolation methods. We were happy to report the progress made with assays for two difficult pathogens – Norovirus and *Yersinia enterocolitica* – in seafood and pork meat respectively. ESR is seeking IANZ accreditation for the Norovirus assay, that was instrumental in the identification of oysters imported from Korea as a notable source of human infection. The *Y. enterocolitica* method is a combination of conventional and molecular methods, is the first of its type and has already shown its worth, with preliminary results showing carriage rates of 18% and 43% in whole and comminuted pork samples, respectively.

The partnership between the NZFSA and ESR continues to mature. The importance of food safety and the long-standing nature of many of the key issues surrounding it are now evidenced in the acknowledgement of longer-term (36 months) scientific programmes in the 2006-2007 contract encompassing risk analysis, domestic food handling, foodborne viruses, *Salmonella* and *Campylobacter*. ESR's scientific advances are being used to develop and inform the work of the NZFSA that, in turn, helps protect the public from foodborne hazards. Together, ESR and the NZFSA are working towards a healthier New Zealand.

Dr Stephen On
Food Safety Programme Leader
Institute of Environmental Science & Research
Christchurch
September 2006

1 INTRODUCTION

The primary purpose of the Food Safety Programme is to provide the New Zealand Food Safety Authority (NZFSA) with information (experimental, monitoring and derived from the scientific literature and expertise of ESR's Food Safety Programme members) to help them to identify and quantify food safety hazards, assess, manage and communicate (to key stakeholders) risks, develop food standards as appropriate and evaluate health outcomes. The Programme is designed to be flexible, to enable the NZFSA to call upon ESR Food Group's wide range of capabilities when needed, so as to assist in achieving the goal of ensuring safe food for both domestic and international consumers.

The Programme is divided into six Science Service Descriptions:

- Microbiological Risk Profiling
- Microbiological Food Safety
- Chemical Food Safety
- Current Awareness and Risk Communication
- Emergency Response
- NZFSA/HPO Technical Support

The 2005-2006 Food Safety Programme was based on Service Descriptions as a means of consolidating like work to introduce organisational tidiness. But, more importantly, it facilitates implementation of a risk management framework by NZFSA for administration of food safety in New Zealand. Qualitative and quantitative risk assessments are central to this approach.

The current report summarises activities carried out under the six Science Service Descriptions during the year July 2005 to June 2006.

2 MICROBIOLOGICAL RISK PROFILING

The New Zealand Food Safety Authority utilises a "regulatory model" that adopts a risk-based approach to food safety. This means, in general, that effort and resources are applied to issues that constitute the greatest risk. However, market access, consumer perceptions and other issues can also have an influence on science needs. The purpose of the Microbiological Risk Profiling Science Service is to provide scientific information that supports this risk-based approach, and also to direct the other scientific food safety activity of ESR so that it also is based on risk assessment.

This Science Service contributes to the risk assessment and management of food safety issues by providing:

- Risk Profiles of food/hazard combinations to provide current status and context to risk managers for decision making;
- Identification of new data and information needed for future risk profiles and effective risk management of food safety issues;
- Direction for research activity to provide that data and information, either within this Service or others.
- Other reports that provide scientific information for risk management of priority food safety issues.

The development of risk-based activities to support risk management decision making is proceeding well. The Risk Profiles are the building blocks of such an approach. As these are finalised, a coherent picture of the food safety issues facing New Zealanders is being created. These Profiles also identify areas of work that are needed to fill data gaps and several of these are being addressed in the other ESR Science Services. In this way, a systematic risk profiling process has underpinned the significant expansion of microbiological risk assessment in the 2005-2006 contract.

The components of this Science Service during 2005-2006 were:

- Risk Profiling
- Food Consumption Data for Risk Assessments

2.1 Risk Profiling

The purpose of a risk profile is to provide a systematic collection of contextual information relevant to a food/hazard combination, such as *Campylobacter* in poultry, so that risk managers can make decisions and, if necessary, take further action. A risk profile can be regarded as providing a decision tool between the identification of a real or perceived food safety issue and a variety of actions, including the commissioning of a quantitative risk assessment, or immediate risk management activity.

A further four Risk Profiles were completed during 2005-2006, with drafts of eight more Profiles and other documents delivered to the NZFSA and stakeholder groups for comment.

The additional completed Risk Profiles were:

Cressey PJ, Lake RJ, Hudson JA. (2006) Risk profile: Mycobacterium bovis *in red meat. ESR Client Report FW0320. Christchurch: ESR.*

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Listeria monocytogenes *in soft cheeses. ESR Client Report FW0382. Christchurch: ESR*

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Listeria monocytogenes *in ready-to-eat salads. ESR Client Report FW0446. Christchurch: ESR*

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Shiga toxin-producing Escherichia coli *in leafy vegetables. ESR Client Report FW0456. Christchurch: ESR*

Eight further Risk Profiles are currently undergoing NZFSA or external peer review prior to being finalised:

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Listeria monocytogenes *in low moisture cheese. ESR Client Report FW0440. Christchurch: ESR*

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Campylobacter jejuni/coli *in mammalian and poultry offals. ESR Client Report FW0465. Christchurch: ESR.*

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Campylobacter jejuni/coli *in red meat. ESR Client Report FW0485. Christchurch: ESR.*

Lake RJ, Hudson JA, Cressey PJ, Gilbert S. (2004) Risk profile: Campylobacter jejuni/coli *in poultry (whole and pieces). ESR Client Report FW04100. Christchurch: ESR* (this is an update of an earlier risk profile).

Gilbert S, Lake RJ, Hudson JA, Cressey PJ. (2005) Risk profile: Shiga toxin-producing Escherichia coli *in raw milk. ESR Client Report FW0612. Christchurch: ESR.*

Gilbert S, Lake RJ, Hudson JA, Cressey PJ. (2006) Risk profile: Clostridium botulinum *in ready-to-eat smoked seafood in sealed packaging. ESR Client Report FW0625. Christchurch: ESR.*

Gilbert S, Lake RJ, Hudson JA, Cressey PJ. (2006) Risk profile: Clostridium botulinum *in honey. ESR Client Report FW05115. Christchurch: ESR.*

Gilbert S, Lake RJ, Hudson JA, Cressey PJ. (2006) Risk profile: Shiga toxin-producing Escherichia coli *in uncooked comminuted fermented meat products. ESR Client Report FW0611. Christchurch: ESR* (this is an update of an earlier risk profile).

Completed Risk Profiles are available on the New Zealand Food Safety Authority website at http://www.nzfsa.govt.nz/science-technology/risk-profiles/index.htm.

2.2 Food Consumption Data for Risk Assessments

For the risk from hazards in foods to be adequately assessed, it is necessary to know the level of exposure. The exposure is derived from the amount of hazard in the food, combined with the amount of food consumed. Thus, food consumption data are fundamental to the risk assessment process.

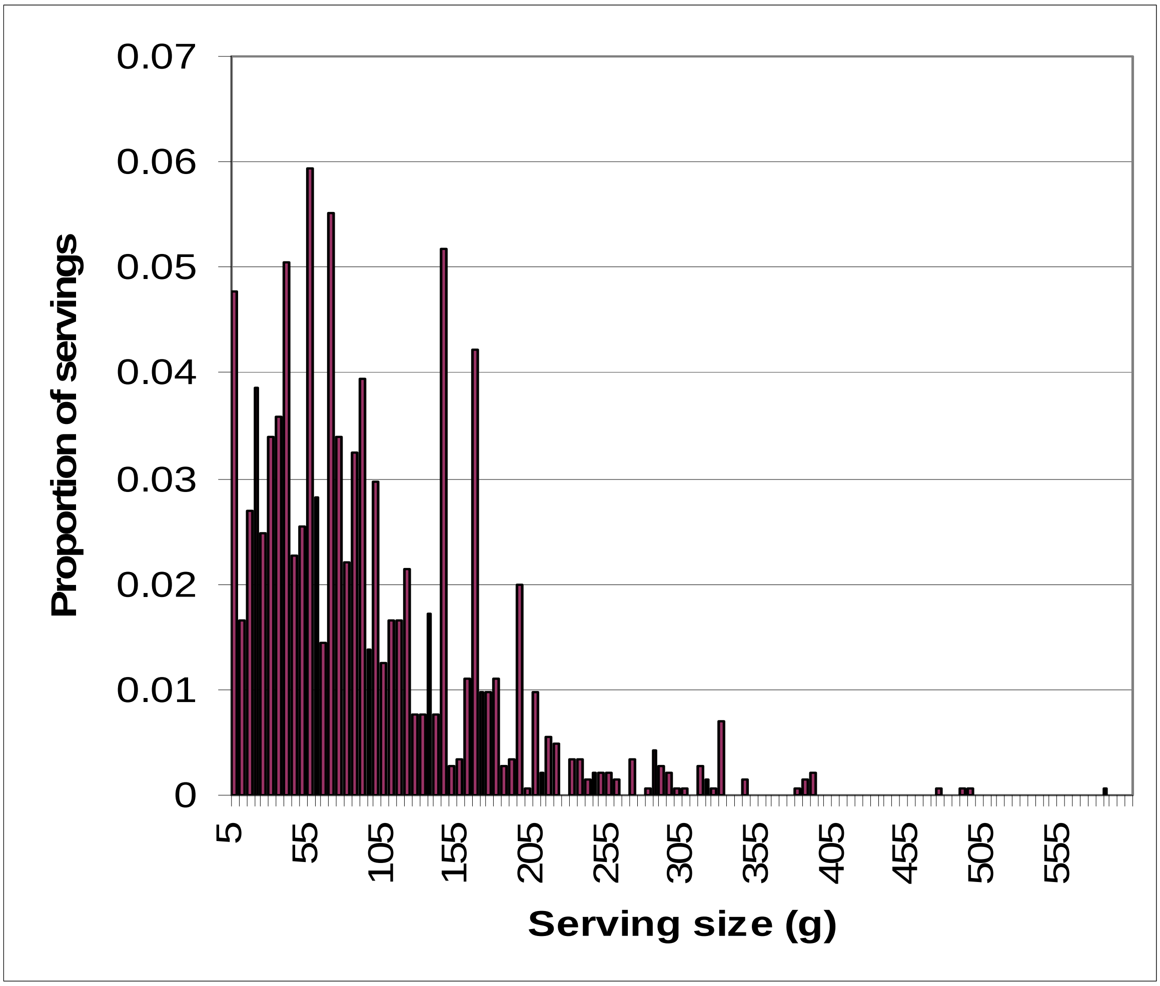
Currently, the best food consumption data available for normal New Zealand population groups are the 1997 National Nutrition Survey and the 2002 Child Nutrition Survey. People who consume a food frequently, or in large amounts, will have greater exposure to any hazards that might be present in that food. The first part of this report utilises the New Zealand nutrition surveys to provide data on food consumption by normal population groups for specific foods of interest. The foods included are milk, cheeses, ice cream, meats, seafood, rice and leafy vegetables.

Figure 1 gives a graphical example of the distributional information that can be obtained from these analyses.

Analysis of the NNS and CNS provides data of value for risk assessment, however the exercise is time consuming. In some instances additional information would aid risk assessment, such as where the food was obtained (e.g. takeaway, home cooked, recreationally harvested). It would be valuable for the NZFSA to have some input into the design of forthcoming surveys, to include such information.

There are groups within the population whose health status places them at greater risk of illness from foodborne hazards. Recognised groups are the young, old, pregnant and immunocompromised. Risk assessment can be improved by obtaining food consumption data specifically for these groups, which for this report have been defined as infants and young children (five years old or less), older people (65 years old or greater), pregnant women (from confirmation of pregnancy until birth) and potentially immunocompromised people with diabetes, HIV/AIDS, cancer or who have received an organ transplant (with the focus on bone marrow transplant patients). Information available on the diets of these higher risk groups has been collated in the second part of this report. The information was sourced from scientific literature, advisory groups, universities and dietitians, and includes published diet studies and dietary advice.

Figure 1: Distribution of chicken serving sizes in the primary 1997 National Nutrition Survey dataset



Of the four 'high-risk' consumer groups identified, the only group that has been assessed for dietary intake on a national level in New Zealand is the older adults group, though the sample set was small and only non-institutionalised residents were surveyed. No national surveys have been conducted on the diets of pregnant women, infants or immunocompromised people such as those with cancer, diabetes, HIV/AIDS or who have received bone marrow transplants. Most dietary advice for these groups focuses on food safety practices, and while some food restrictions are advised, no evidence was located to indicate the proportion of people adhering to this advice (which, if 100%, would represent zero exposure, and zero risk). There have been numerous localised dietary surveys conducted for these high-risk groups. However, in most cases, the results are presented as nutrient information and energy values only, when information is published. Obtaining and collating the raw data from these studies could provide a valuable resource to more accurately estimate exposure of these high-risk groups to hazards in any particular food.

Cressey PJ, King N, Lake RJ. (2006) Food consumption data for risk assessments. ESR Client Report FW0602. Christchurch: ESR.

3 MICROBIOLOGICAL FOOD SAFETY

The aim of this Science Service is to improve food safety in New Zealand by providing information on the microbiological quality of our foods, assessing the risks posed by microbiological hazards in foods, identifying efficiencies in controlling those risks and contributing to the overarching risk management goals of NZFSA.

Ongoing monitoring and surveillance of current, emerging or potential food microbiological safety issues may include testing a range of selected foods from the retail market or validating methods used within food businesses to assess food safety and hygiene. Where new hazards emerge, new methods may need to be developed to detect them, as part of this programme.

Results of projects can be used to advise on potential hazards, the risk to human health posed by them, and methods of control. This may in turn lead to new or revised regulatory standards, and other risk management options such as development of codes of practice (COPs) for industry, provision of food safety resources for use in consumer education campaigns, or advice to food producers to change their methods or practices.

Specific work areas included in the 2005-2006 year were:

- Implementation and Optimisation of the National Typing Database: PFGE Typing of Residual Survey Isolates
- Prevalence and Numbers of *Campylobacter* and *Salmonella* on Chickens Prior to Scalding
- Quantitative Risk Assessment: *Campylobacter* in Red Meat and Poultry from Retail to Human Consumption
- Further Development of a Risk Model for *Campylobacter* in Poultry in New Zealand
- Survey of *Salmonella* Contamination of Retail Eggs
- Further Development of a Risk Model for *Salmonella* in Poultry in New Zealand
- Microbiology of Uncooked Retail Meat Products: *Salmonella* and STEC
- Shiga Toxin Production by STECs Isolated from the Microbiology of Uncooked Retail Meat Products Project
- Microbiological Survey of Imported and Domestic Pet Chews: *Salmonella*
- Domestic Food Practices
- *Yersinia* in meat: Analytical Development and Survey
- Exposure Assessment of *Listeria monocytogenes* via Unpackaged Ready-to-eat Meats
- Exposure Assessment to *Listeria monocytogenes* via Deli Ready-to-eat Salads (with Dressings)
- Analytical Development: Norovirus Detection
- Inactivation of Norovirus by Low Temperatures
- Modular Contribution to NZFSA Pasteurisation Risk Model
- Resuscitation of Putative Viable but Non-culturable Foodborne Bacteria of Significance to New Zealand
- Validation of Visual Inspection of Foods in Relation to Critical Limits

3.1 Implementation and Optimisation of the National Typing Database: PFGE Typing of Residual Survey Isolates

Activity under this project was deferred and will be completed in the 2006-2007 year.

3.2 Prevalence and Numbers of *Campylobacter* and *Salmonella* on Chickens Prior to Scalding

The aim of this project was to produce quantitative and qualitative data for *Campylobacter* and *Salmonella* on ex-sanguinated broiler chickens sampled prior to scalding in four poultry processing plants.

A total of 200 birds (50 from each plant) from 39 flocks supplied by 30 farms were sampled over 41 consecutive weeks. Whole bird rinsates were tested for presence and numbers of *Campylobacter* and *Salmonella*, while caecal swabs were tested only for the presence of these pathogens.

Campylobacter spp. were isolated from 100% of birds, with counts ranging from 1.53×10^2 to 2.90×10^9 CFU bird^{-1}. There was no significant difference in the mean counts of *Campylobacter* between the plants (P>0.05). Caecal swab cultures from 35 flocks of birds were positive for *Campylobacter*, giving a flock prevalence of 89.7%. *Salmonella* spp. were isolated from the rinsates of 49 birds (a prevalence of 24.5%), supplied by Plant A (69.4%) and Plant D (30.6%). *Salmonella* counts ranged from 12 to 3×10^3 CFU or MPN bird^{-1}. The caecal content of only one bird was positive for *Salmonella.*

It was concluded that the results generally reflect on the microbiological status of New Zealand retail poultry, which is highly contaminated by *Campylobacter* but less commonly contaminated by *Salmonella*. Detecting *Campylobacter* and *Salmonella* on the external surface of chickens despite its absence from caecal swabs indicates that cross contamination from the environment to uninfected birds may have occurred during transport. This occurrence is much more frequent with *Salmonella* than for *Campylobacter*, indicating that the main source of contamination of broiler chickens by *Salmonella* may be occurring post-harvest. The data generated from this study will be used to populate quantitative risk models for *Campylobacter* and *Salmonella* in poultry.

Wong TL, Havelaar P, Nicol C, Hudson JA. Campylobacter *and* Salmonella *on broiler chickens entering four poultry processing plants in New Zealand. Draft paper prepared for submission to International Journal of Food Microbiology.*

3.3 Quantitative Risk Assessment: *Campylobacter* in Red Meat and Poultry from Retail to Human Consumption

A computer-based model has been constructed using @RISK software to estimate and compare exposures of New Zealanders to *Campylobacter* from three types of red meat (sheep, pigmeat, beef) and poultry. The scope of the model is from consumer purchase to consumption. Extensive survey information on the prevalence and numbers of *Campylobacter* in retail samples of these meats are key inputs.

Four potential exposure routes have been assessed:

- From external contamination of packaging;
- Ingestion from contamination of hands during food preparation;
- Transfer of bacteria to a second food which is not cooked before consumption, and
- Undercooking.

Various data have been collated to estimate the likelihood and number of bacteria for these exposures, and the numbers of daily events of these types in New Zealand. The exposures have been translated into estimates of infection and illness using a dose-response relationship.

The model results indicate that, of the foods considered, poultry is by far the major exposure route for campylobacteriosis in New Zealand. Using the available data on number of bacteria means that exposures from red meat are negligible. This situation applies even if the numbers of bacteria on contaminated red meat are raised to be the same as poultry (this may be true as there will be high uncertainty associated with data from the low numbers of positive red meat samples). Under this scenario small numbers of infections from red meat exposures do occur, but are approximately 20-fold lower than for poultry.

Lake R, Hudson JA, Cressey P, Bayne G. (2006) Quantitative risk model: Campylobacter spp. in red meat. ESR Client Report FW0619. Christchurch: ESR.

3.4 Further Development of a Risk Model for *Campylobacter* in Poultry in New Zealand

This report describes the development of a quantitative risk model to investigate *Campylobacter* spp. contamination in the processing and consumption stages of the New Zealand poultry food chain. It covers work during the period 2003-2005.

The output of the model is intended to describe the exposure of New Zealanders to *Campylobacter* from poultry, in terms of the probability that an exposure (e.g. a poultry meal) will be contaminated, and if so, the numbers of bacteria involved. The purpose of the model is to assess the effect of changes in the poultry food chain on that exposure. This is intended to support the development of risk management measures by the New Zealand Food Safety Authority.

The model describes each step in the chain in terms of the probability of a carcass or food serving being contaminated with *Campylobacter* and the numbers of bacteria present. Within a risk assessment, the model output (exposure) can be applied to dose response information to provide a risk characterisation that predicts the numbers of infected (or ill) people. However, there is considerable uncertainty in this prediction for a number of reasons. A dose-response step has been included in the current model, but with appropriate caveats.

The model itself consists of two computer files written using the @RISK software. The files describe the following:

- Flock sequence model, describing the sequence of contaminated and uncontaminated flocks entering primary processing; and,
- Primary processing and food handling model.

Processing includes primary processing (from entry to the slaughter house to after the immersion chiller) and secondary processing (portioning, storage, distribution) up to purchase by the domestic consumer or foodservice sector. The model examines the effect on the prevalence and numbers of bacteria through the primary processing steps, including cross contamination at the defeathering stage. The carcasses are then directed into one of two channels: domestic or foodservice. The foodservice channel is then further split into three: fast food outlets, restaurants, and "other".

In each of these channels, the probability of contamination and numbers of bacteria in four potential human exposures are considered: during food purchase, during food preparation, cross contamination to a secondary food, and undercooking.

The model indicates a modest decrease in the prevalence of contamination (by approximately 20%) during primary processing. However, the numbers of bacteria on a carcass reduce markedly, from a mean of 6.5 $\log_{10}$ CFU/carcass at entry, to 2.6 $\log_{10}$ CFU/carcass after the immersion chiller.

The number of positive exposures is heavily weighted to the domestic channel (approximately 90%) over the foodservice channel. The probability of infection is greatest for ingestion of cells resulting from cross contamination of another food, followed by contamination of hands during food preparation. Ingestion of cells from contamination of hands from packaging, or survival of cells resulting from undercooking, represent only small contributions to the overall probability of infection.

The model outputs appear reasonable in terms of the numbers of bacteria on a carcass. The available data indicate a prevalence of infected flocks of 0.33, from which the model appears to underestimate the prevalence of contamination in the fresh poultry supply, based on survey data. One possible reason for this is that cross contamination during secondary processing is underestimated; the potential for cross contamination during handling in supermarkets has not been explicitly included. Alternatively the actual prevalence of infected flocks may be greater than 0.33.

The model predicts a daily number of ill people which translates into an estimate of the number of campylobacteriosis cases that might occur in New Zealand each year. This prediction is not inconsistent with data from notifiable disease surveillance, but there is considerable uncertainty associated with the dose-response relationship. This is particularly so for the numbers of cells for exposures predicted by the model, almost all of which are less than 1000 cells.

Analysis indicates that a reduction in the prevalence of infected flocks achieves a linear decrease in predicted cases; a reduction in the number of bacteria on the exterior of birds by a factor of 100 (2 $\log_{10}$) is required to achieve the same reduction in predicted cases as a four-fold decrease in prevalence of infected flocks.

The model is flexible, and can be readily altered to accommodate different conditions; the effects of logistic slaughter and freezing have been investigated in this report. The former appears to produce only modest reductions in numbers of infections, while the effect of freezing the entire supply does reduce the risk of illness considerably, as would be expected. The practical feasibility and consumer acceptability of the freezing option is another matter.

Lake RJ, Hudson JA, Cressey PJ, Bayne G. (2006) Quantitative risk model: Campylobacter spp. in the poultry food chain. ESR Client Report FW0520 (Updated). Christchurch: ESR.

3.5 Survey of *Salmonella* Contamination of Retail Eggs

This project was still in progress at the time of finalising the current report.

All sampling and analyses have been completed and a summary of the results sent to the Egg Producers Federation. Farm location and egg washing data still to be followed-up but EPFNZ (egg Producers Federation of New Zealand) have been contacted to assist with this.

Tests have been completed on 514 sample units - 250 (49%) cage, 161 (31%) free range, and 103 (20%) barn (target split was 50% cage, 30% free range and 20% barn). No contents have been found positive for *Salmonella* (represents contents of approx 3710 eggs).

Nine shell surface samples have been found positive (overall prevalence of surface contamination - 9 positives from 514 sample units = 1.8%). All isolates were *Salmonella* Infantis and all were from cage laid eggs. Levels for eight of the samples were <5 CFU/egg, and 44 CFU/egg for the other sample. Positive samples are from four "brands" (including two house brands).

Pulse field typing has not yet been completed on the isolates due to delayed delivery of a reagent (expected towards the end of this month). Once these results are available the format of final report will be discussed with NZFSA and EPFNZ.

3.6 Further Development of a Risk Model for *Salmonella* in Poultry in New Zealand

This report describes further progress in the development of a quantitative risk model to evaluate contamination by *Salmonella* spp. in the New Zealand poultry food chain. The report covers work during 2005-2006.

The prevalence of *Salmonella* in the New Zealand poultry food supply dropped markedly during the 1990s, as a result of risk management efforts by member companies of the Poultry Industry Association of New Zealand (PIANZ). Consequently the purpose of the *Salmonella* model is not to support the development of new risk management measures, but (as described in the project specification) to:

- Elucidate the influences on *Salmonella* prevalences and bacterial counts in poultry in New Zealand, in order to support the maintenance of, and to improve, existing control measures;
- To evaluate poultry and livestock rations as a hazard pathway; and,
- To identify data gaps and direct future research requirements.

During 2004-2005, amongst other activities, this project developed a detailed overview of the poultry industry structure in New Zealand, as well as gathering details of feed production and feedmill operation. A UK model for *Salmonella* in poultry was obtained from the developers, which was based on a Bayesian belief network constructed in Netica software.

A review of the literature indicated that overall, primary processing had little effect on the prevalence of *Salmonella* on broiler carcasses, and the most important influences were considered to be on-farm factors, including contamination in feed.

During 2005-2006 the following work has been undertaken:

- Development of a model for feed production using @RISK software;
- Visits to two grow-out farms in May 2006 to observe and provide information to support development of parameters for the Netica model
- Further development of the Netica model for on-farm risk factors for contamination of broilers with *Salmonella*;
- Liaison with the poultry industry, including a visit to a meeting of the PIANZ Technical Committee in November 2005.

The Poultry Industry Association of New Zealand Veterinary Technical Group have indicated that, in their opinion, the key factors in minimising *Salmonella* contamination of broilers were prevention of contamination in feed, and preventing infection of breeder flocks. The @RISK model of feed production indicates that conditioning, if properly conducted, will reduce *Salmonella* to a very low proportion of the production, and the remaining numbers of any residual bacteria are low.

The Netica model has been parameterised on the basis of limited literature information and information gathered and comments made during visits to grow-out farms. Actual parameter values were guided by examination of values chosen for the other nodes assigned by the UK modelers. In essence, the model simply reflects the opinions of the project team as to the importance of various factors. The value of creating the Netica model for on-farm factors is thus:

- To consolidate information on a large number of factors into a single output;
- To provide some quantitative estimates for the probability of infection; and,
- To provide a graphical tool to indicate the effect of changes.

Modelling indicates that key influences on contamination are: infection of breeding stock, feed contamination, and contamination during transport from grow-out farm to processing, and these offer opportunities to further reduce risks to consumers. The first of these appears to be under good control, with extensive monitoring for *Salmonella* during breeding. There is intermittent contamination of feed with *Salmonella* in New Zealand and anecdotal information suggests that this is due to plant contamination rather than conditioning failures. Of the on-farm factors, it appears that there is considerable potential for cross contamination between birds during transport and waiting times at primary processing.

Lake RJ, Hudson JA, Cressey PJ, Bayne G. (2004) Quantitative risk model: Salmonella spp. in the poultry food chain. ESR Client Report FW0629. Christchurch: ESR.

3.7 Microbiology of Uncooked Retail Meat Products: *Salmonella* and STEC

This project was reported in two draft papers formatted in the style of the Journal of Food Protection.

Salmonella in Uncooked Retail Meats in New Zealand

A national quantitative survey of *Salmonella* in five types of uncooked retail meats was undertaken from August 2003 to May 2005 to establish baseline proportionality data. The overall prevalence of *Salmonella* in 1108 meat samples was 1.1% (95% Confidence Interval 0.6-1.9). Low prevalence of *Salmonella* in each meat type was observed, with 0.4% (0–2.4) in beef, 0.5% (0–3.0) in unweaned veal, 3% (1.2–6.1) in chicken, 1.3% (0.3–3.8) in lamb/mutton and 0% (0–1.6) in pork.

Salmonella serotypes isolated were *S*. Infantis from beef, *S*. Typhimuriun DT 1 from unweaned veal and chicken, *Salmonella* sp. 6,7:k:-, *S*. Enteritidis PT9a, *Salmonella* sp. 4,5,12:-:-, *Salmonella* sp. 4,12:-:- and *S*. Typhimurium DT160 from chicken, and *Salmonella* sp. 4:-:2 and *S*. Brandenburg from lamb. The three *Salmonella* sp. 4,5,12:-:- and *Salmonella* sp. 4,12:-:- isolates from chicken were very similar phenotypically and serologically to the attenuated *Salmonella* vaccine strain used in Megan™Vac1 for poultry.

One lamb sample yielded a count of 4.24 MPN/g of *S.* Brandenburg while all other positive samples were <1.0 MPN/g.

The results provide baseline proportionality data for *Salmonella* in retail uncooked meats that will contribute invaluably towards future risk assessment in combination with other information, such as consumption data.

Shiga toxin-producing *Escherichia coli* and *E. coli* biotype 1 in uncooked retail meat products in New Zealand

A national quantitative survey of shiga toxin-producing *Escherichia coli* (STEC) and generic *E. coli* in 878 samples of uncooked retail meats in New Zealand was undertaken from August 2003 to May 2005 to establish baseline proportionality data. The prevalence of STEC was 5.2% (95% Confidence Interval 2.7-8.8) in beef, 2.2% (0.6-5.5) in unweaned veal, 14.7% (10.4-20.0) in lamb/mutton and 6.5% (3.7-10.5) in pork.

The counts of STEC obtained from positive meat samples were very low; one sample of lamb produced a count of 3.3 MPN/g, five samples (1 beef, 3 lamb and 1 pork) with counts of 1.0 MPN/g, four samples (2 lamb, 1 mutton and 1 pork) with 0.33 MPN/g and 49 samples with <0.33 MPN/g. Counts in three lamb samples were estimated at >1 MPN/g and one sample each of pork and lamb was estimated at <3.3 MPN/g.

Sixty-five isolates of STEC were identified, of which five were *E. coli* O157:H7 and two were *E. coli* O26:H11 isolates possessing *stx*1 and/or *stx*2 genes in conjunction with the intimin (*eae*A) and enterohaemolysin (*hly*A) genes. Less than 13% of 877 samples had *E. coli* biotype 1 counts above 100 CFU/g, 2.5% were above 1000 CFU/g and only 0.8% exceeded 5,000 CFU/g.

The results provide baseline proportionality data for STEC and *E. coli* biotype 1 in four uncooked retail meats that will contribute invaluably towards future risk assessment in combination with other information, such as consumption data.

Wong TL, Hollis L, Cornelius A, Bennett J, Cook R. Shiga toxin-producing Escherichia coli *and* E. coli *biotype 1 in uncooked retail meat products in New Zealand. Draft paper prepared for submission to Journal of Food Protection.*

3.8 Shiga Toxin Production by STECs Isolated from the Microbiology of Uncooked Retail Meat Products Project

The aim was to evaluate the usefulness of the Duopath® Vero toxin kit to screen for toxin production by Shiga toxin-producing *Escherichia coli* isolated from meat samples.

Sixty-five STEC strains isolated from meat sources (see section 3.7 of this report) were analysed for Shiga toxin 1 and Shiga toxin 2 production using the Duopath® kit in conjunction with Vero cell assay. All isolates were cytopathogenic to Vero cells and 46 isolates carrying the *stx* 1 gene were VT1 positive in Duopath®. Of the 38 isolates that carried the *stx* 2 gene, 15 tested positive for VT2 and 23 tested negative. Sixteen isolates would miss detection as an STEC if both *stx* 1 and 2 genes were not present. Seven isolates that carried only the *stx* 2 gene were missed completely by Duopath®. Only three out of five *E. coli* O157:H7 isolates producing VT2 bands would be detected.

The findings from this project did not support the use of the Duopath® Vero toxin kit as a screening tool for STEC isolates from meat samples. STEC carrying an *stx* 2 gene may miss detection. Specific serotyping of the isolate coupled with Vero cell assay and a multiplex PCR screen is essential for a full identification of an STEC culture.

Wong TL, Cornelius A, Bennett J, Nicol C. Using Duopath verotoxin test kit to detect Shiga toxin from Shiga toxin-producing Escherichia coli *isolated from retail meats in New Zealand. Draft paper prepared for submission to Letters of Applied Microbiology.*

3.9 Microbiological Survey of Imported and Domestic Pet Chews: *Salmonella*

The aims of this project were to survey the prevalence of *Salmonella* in imported and domestic pet chews to assess their:

(1) Potential to introduce novel pathogenic and antimicrobial resistant strains into New Zealand, and
(2) Role as vehicles of salmonellosis in the domestic home environment.

Three hundred samples each of imported and domestic pet chews were analysed qualitatively for *Salmonella*. Immuno-magnetic separation using Dynabeads® anti-*Salmonella* was used to concentrate *Salmonella* from pre-enriched culture followed by selective enrichment in Rappaport-Vassiliadis Soya Peptone broth. Selective plating on Xylose Lysine Desoxycholate and Hektoen Enteric agars resulted in 16 (5.3%) isolations of *Salmonella* from imported pet chews, and 20 (6.7%) isolations from domestic pet chews. The prevalence of *Salmonella* in imported and domestic products was not significantly different (P>0.05, Chi square test).

Salmonella Borreze isolated from Australian rawhide has never been recorded before in New Zealand. Three isolates of *S.* London from Australian pet chews were resistant to ampicillin and gentamicin, and two isolates of *S*. Infantis from Chinese pet chews were resistant to nalidixic acid, one of which was also resistant to streptomycin.

It was concluded that novel pathogenic and antimicrobial-resistant *Salmonella* are being introduced into New Zealand through the importation of pet chews, but the significance of this exposure pathway has yet to be determined. Pet chews are a potential source of exposure to *Salmonella* in the domestic home environment and humans are at risk of exposure either directly, through handling, or inadvertently by cross-contamination of food contact surfaces and food in the home environment.

Wong TL, Thom K, Nicol C, Heffernan H, MacDiarmid S. Salmonella *serotypes isolated from Pet Chews in New Zealand. Draft paper prepared for submission to Journal of Applied Microbiology.*

3.10 Domestic Food Practices

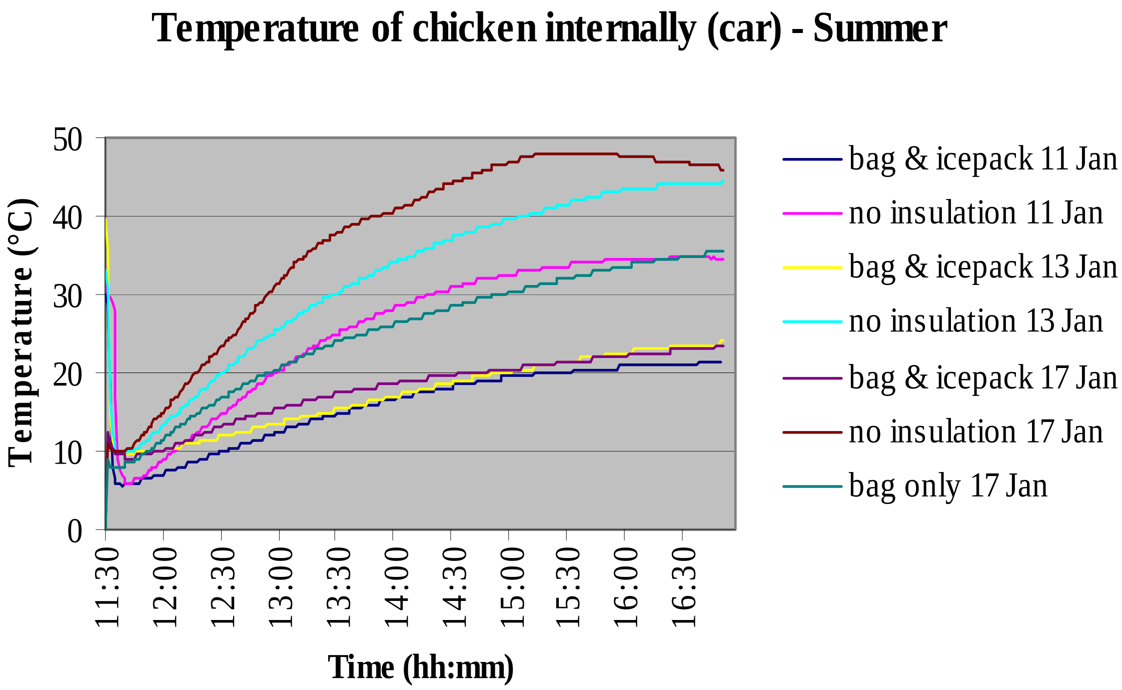
A significant proportion of foodborne illness is thought to be caused by unsafe food handling practices in the home. Data on the food handling practices of New Zealanders are limited. This project was initiated to provide more, and better targeted, information on domestic handling of meat and poultry in New Zealand. The information is needed to support risk assessment by the New Zealand Food Safety Authority, particularly the development of quantitative risk models.

The project was carried out over two years; July 2004 – June 2006. During the period 2004-2005, the project developed and administered two surveys; one on refrigerators, including measurements of operating temperatures, and a postal survey investigating meat and poultry handling practices, including aspects of food purchasing and transport relevant to food safety.

During the 2005-2006 period covered by this report, the project has principally investigated temperature profiles for meat and poultry during simulated transport home, and transfer rates of *Campylobacter* under simulated domestic handling conditions.

Meat and poultry packs were stored under various packaging conditions and placed either in a car boot or car interior to simulate the period between purchase and storage of these products in the home. The temperatures of the products were monitored over several hours during three experiments each in summer and winter. Rates of temperature increase were determined to provide parameters to allow the estimation of temperature changes for modelling purposes. Figure 2 shows a typical experimental result from this study.

Figure 2: Typical meat temperature profile during simulated transport



Cross contamination from raw poultry to surfaces, hands, and other foods, is often cited as the key route for ingestion of *Campylobacter* originating from poultry in the home, as proper cooking readily eliminates the organism. During several preliminary experiments, this study developed a protocol, with sufficient sensitivity to determine the low rates of bacterial transfer that occur during such processes. The study used naturally occurring *Campylobacter* on poultry. This approach presented sensitivity challenges, but avoided the need to artificially spike samples with bacteria. The protocol was used to investigate transfer rates for *Campylobacter* under simulated handling of poultry breast meat portions. Transfer rates were low (<5%), but consistent. A summary of transfer experiment results is presented in Table 1.

Table 1: *Campylobacter* transfer from 3 chicken breast portions to cutting board, hands, knife, and "lip" during the dicing of skinless chicken breast portions

Transfer from chicken breasts to	Mean proportion of *Campylobacter* transferred (%)	Standard Deviation (%)
Chopping board	1.46	1.95
Knife	0.29	0.28
Hands	1.17	0.84
"Lip"	0.05	0.11

These studies provide valuable data that can be used as generic inputs into quantitative risk models. The data on temperature increases during transport home provide graphic illustration of the importance of using insulated packaging, and storing food out of direct sunlight. The transfer rate data are similar to those from the most recent overseas publication on the topic, but incorporate the variability inherent in individual chicken portions without the need to make assumptions about uniformity of contamination. In addition, an important transfer step, from fingers to lips, is simulated. The total bacterial budget approach avoids the need to estimate such variables as proportion of surfaces in contact, and the use of different operators in the experiments goes some way to mimicking the variability that could be expected amongst the population performing the same task.

Although the transfer rates determined in these experiments are low, the use of similar values in the New Zealand *Campylobacter* in poultry risk model indicate that with frequent potential exposure events, significant numbers of illnesses are likely to result.

Gilbert S, Bayne G, Wong TL, Lake R, Whyte R. (2005) Domestic food practices in New Zealand. 2005-2006 Project Report. ESR Client Report FW0640. Christchurch: ESR.

3.11 *Yersinia* in meat: Analytical Development and Survey

The detection and isolation of pathogenic *Y. enterocolitica* from foods is confounded by the likelihood that the bacterium is present in small numbers, and by the possible presence of faster-growing microflora and other *Yersinia* species. An improved method for the detection (presence/absence) and enumeration from meat of *Y. enterocolitica* containing the pYV virulence plasmid (*Ye*P+) is reported. The detection method combines a multiplex PCR targeting the *ail* and *virF* genes with a number of selective media, which were evaluated for their capacity to detect, isolate and identify *Ye*P+ from the surface of meat portions and from comminuted meats.

Enumeration is achieved using the most-probable number (MPN) method. A presumptive result is available within 24 hours of sample receipt and any *Ye*P+ isolates confirmed within four days. The conservative detection limit for meat surfaces was 10 CFU/cm^2, and was 100 CFU/g for comminuted meats.

The presence/absence and MPN methods were evaluated in a pilot survey of 41 raw pork meats purchased from retail outlets in Christchurch, New Zealand. *Ye*P+ was detected by PCR on 32% of whole meat samples tested (steak, chop, schnitzel) and in 86% of the comminuted meat samples. *Ye*P+ isolates were obtained from 18% and 43% of the whole and comminuted meat samples, respectively. The count of *Ye*P+ on whole meat samples ranged from 0.30 to 5.42 MPN/cm^2, and from 0.31 to >42.90 MPN/g in comminuted meats. This improved method for the detection and enumeration of *Ye*P+ from meat samples will be used to provide data for exposure assessment and is amenable to outbreak investigations.

King N, Hudson AJ. (2006) Detection and enumeration of Yersinia enterocolitica *from raw pork: Pilot survey. ESR Client report FW0645. Christchurch: ESR.*

3.12 Exposure Assessment of *Listeria monocytogenes* via Unpackaged Ready-to-eat Meats

The aim of the project was to produce data on the prevalence and numbers of *L. monocytogenes* in unpackaged ready-to-eat ham to enable this transmission route to be assessed in terms of relative risk to the population, and to inform risk mitigation prioritisation.

A total of 301 unpackaged ham samples purchased from retail outlets in Auckland, Wellington and Christchurch were examined for the presence and number of *L. monocytogenes* after storage in a laboratory refrigerator for seven days at 5°C prior to analysis (to simulate domestic storage conditions). Of the samples tested 13 (4.3%) contained the pathogen. Eight contained the organism at <50 CFU/g three contained 50 CFU/g, one 1.5 x 10^2 CFU/g and one 1.6 x 10^3 CFU/g. In addition 13 samples contained other *Listeria* spp., 11 containing *L. innocua* and two *L. welshimeri* at <50 CFU/g. *L. monocytogenes* and *L. innocua* were isolated from the same sample on three occasions.

In other experiments attempts were made to identify *Listeria*-contaminated batches of retail ham and to incubate them at 5°C over approximately three weeks to assess the rate of growth of natural contaminants in this food. No batch of ham in which growth occurred, or where *Listeria* spp. could be isolated on repeated sampling, contained *L. monocytogenes*. However growth curves were obtained for one sample containing *L. welshimeri* and four samples containing *L. innocua*. Growth was slow in all but one sample; with most in the range of approximately 0.002 to 0.004 log h^{-1}. However, in one sample *L. innocua* grew at 0.02 log h^{-1}, although the maximum number reached was only 4.0-5.0 x 10^3 CFU/g. In five other batches of ham *Listeria* spp. could be detected intermittently during incubation, indicating that little growth, if any, occurred.

In conclusion, *Listeria monocytogenes* was isolated infrequently from the ham samples tested. When present the pathogen was usually at low numbers, but the two samples exceeding 100 CFU/g indicate that improvements in handling of this food in retail outlets is desirable. Growth of naturally occurring *Listeria* spp. in ham at refrigeration temperatures was generally slow or did not occur, and moderate levels were reached only after incubation periods which would be most unlikely to occur in foods deemed fit for consumption.

Hudson JA. (2006) Exposure assessment of Listeria monocytogenes *via unpackaged ready-to-eat ham. ESR Client Report FW0646. Christchurch: ESR.*

This report contains the draft of a scientific paper:

Cornelius AJ, Hudson JA. (2006) Enumeration of Listeria monocytogenes, *and growth of naturally-occurring* Listeria *spp., in unpackaged ham. Prepared for submission to the Journal of Applied Microbiology.*

3.13 Exposure Assessment to *Listeria monocytogenes* via Deli Ready-to-eat Salads (with Dressings)

The aim of this project is to provide information on the levels and prevalence of *L. monocytogenes* in ready-to-eat salads (with cooked or processed ingredients, with or without dressings). These data were required to fill gaps identified in the RTE salad Risk Profile and to update surveillance information from 1997.

The project goal is to examine 300 samples over 12 months (sampling started in February 2006) and spanning two financial years (sampling finishes in January 2007). As of 26 July 2006, 139 samples have been examined for *Listeria* spp. and six samples were positive. Four samples (two samples of seafood cocktail, coleslaw, and pasta and cheese salads) were positive for *L. monocytogenes*. A count of 100 CFU/g was enumerated from the coleslaw sample. The other three samples all contained counts <10 CFU/g. One seafood cocktail salad was also co-contaminated with *L. welshimeri*. This represents an interim prevalence of 2.9% for *L. monocytogenes* in deli ready-to-eat salads. Two other samples positive for *Listeria* spp. were contaminated with *L. ivanovii* and *L. welshimeri* respectively. Counts in both samples were <10 CFU/g. The pH measurements of all the positive samples exceeded 4.5.

The project will be completed in the 2006-2007 year.

3.14 Analytical Development: Norovirus Detection

This project was initiated during the 2003/2004 year. During year two of the project, evaluation of norovirus recovery methods from oysters and development of a generic norovirus real-time RT-PCR assay continued.

A method for detection of noroviruses in bivalve molluscan shellfish has been developed, evaluated and validated for use in New Zealand. It comprises a protease digestion step to extract virus from the shellfish gut tissue followed by real-time RT- PCR assays to detect GI and GII noroviruses. An internal standard is incorporated into the assay to check sample validity and provide a quality control measure. The method is currently being validated with naturally contaminated oysters from New Zealand outbreak situations. An application for IANZ accreditation has been made.

3.14 Inactivation of Norovirus by Low Temperatures

There is little information on the survival and persistence of enteric viruses at low temperatures. The aim of this project was to determine the effect of low temperatures on the persistence of human noroviruses.

Human noroviruses can still not be grown in cell culture so it is currently only possible to investigate their persistence at low temperatures using molecular techniques. Real-time quantitative RT-PCR was used to determine the effect of storage for up to 14 days at -30ºC and -80ºC on four Genogroup I and Genogroup II norovirus strains. A significant decrease in titre was observed following storage at -30°C for GI/2 and GII/6,7,9 norovirus strains and for GI/2 and GI/4 following storage at -80ºC. The rate of freezing was also studied. No significant difference was observed between freezing at a normal rate versus freezing at a slow rate. GI and GII norovirus strains showed small reductions in titre following storage for up to 14 days at low temperatures but no difference in titres when subjected to slow freezing.

3.15 Modular Contribution to NZFSA Pasteurisation Risk Model

The NZFSA is in the process of defining the level of safety provided by pasteurisation as part of a risk assessment for dairy products in New Zealand. The overall risk assessment will provide a tool for the evaluation of alternative dairy processing options and for comparing risks from dairy products made from unpasteurised compared with pasteurised ingredients.

The project will develop a model that describes the level of protection through the dairy food chain. The model has a series of modules: ESR is primarily undertaking the development of the domestic handling module. This is described as the part of the dairy food chain from consumer purchase to consumption.

A prototype model has been constructed using Analytica software. The model includes all the 14 hazards being considered by this project, and four food groups: milk, soft cheese, low moisture cheese, and other. An initial temperature and numbers of hazard bacteria present are assigned. The growth potential of hazards in the food/hazard combinations are considered during transport home from the purchase point, and during refrigerated storage in the home. The number of bacteria in the food at consumption is combined with serving size data to estimate exposure. Dose-response relationships translate the exposure into estimated numbers of cases.

The model has been populated with generic information such as transport times and temperatures, refrigerator temperatures, and food consumption data. Of the hazards, *Listeria monocytogenes* has been modelled, being the bacterium with the greatest amount of information on growth and dose-response. Further work will need to address growth models and dose-response relationships for other hazards.

Lake RJ, Bayne ,G Hudson JA, Cressey PJ. (2006) Pasteurisation risk model. Development of domestic consumption module 2005-2006. ESR Client Report FW0624. Christchurch: ESR.

3.16 Resuscitation of Putative Viable but Non-culturable Foodborne Bacteria of Significance to New Zealand

This project was initiated during 2005-2006, with activity during the year including establishment of methods and recruitment of a post-graduate student. Work will continue during the 2006-2007 and 2007-2008 years.

3.17 Validation of Visual Inspection of Foods in Relation to Critical Limits

The aim of this project was to determine whether visual inspection of meats during cooking, rather than the use of a temperature probe, is an option for food businesses to assess whether safe limits have been achieved.

The project was divided into two parts: firstly a review of the scientific literature was undertaken to determine whether validation of visual inspection as an alternative to temperature measurement had been carried out. The intention of the second part of the project was to carry out a series of practical experiments to determine if a correlation exists between visual perception of colour change and the critical limits achieved.

The conclusion reached following the literature review was that the colour of a meat product, once cooked, is not a good indication that the food has reached a microbiologically safe internal temperature. Cooked meat may be visually brown and ‘well-done’ in appearance, yet the internal temperature may not be high enough to ensure the inactivation of pathogenic microorganisms. This condition, termed premature browning, may occur with certain meats, and can be induced by storage in high-oxygen modified atmospheric packaging, prolonged thawing, frozen storage, and the addition of salts. At the other extreme, there are numerous factors that prolong pink colour in meats, so that they do not appear to be adequately cooked. This condition is more an issue for food quality, and use of a visual indicator will result in products being overcooked. On this basis, there can be no confidence in visually inspecting a meat product to ascertain if it is safely cooked, and use of a food thermometer is the only reliable method for guaranteeing the inactivation of foodborne pathogens in cooked meat.

As a result of these findings, no experimental work was undertaken. Instead, resources were put into writing a review paper using the information gathered for the literature review (see reference below) and surveying a range of premises that have approved Food Control Plans (FCPs), to clarify how critical limits for meat cooking were being determined, validated and monitored. All FCPs had been developed for premises by consultants and most had been through several revisions to simplify them. All recipes had been checked to ensure critical limits could be achieved. Most supervisors found it more effective to have staff use a food thermometer to monitor the temperature of every batch of cooked food rather than checking on a periodic basis.

King NJ, Whyte R. (2006) Does it look cooked? A review of factors that influence cooked meat color. Journal of Food Science; 71(4): R31-R40.

4 CHEMICAL FOOD SAFETY

International food chemical safety issues such as dioxins in Belgian foods, illness from Coca-Cola in Europe, Genetically Modified Foods (GMFs), chloropropanols in soy-based foods and acrylamide continue to reinforce chemical food safety as a priority area of regulatory activity.

Food chemical safety issues can represent a risk to both public health and trade, both of which are key responsibilities of the NZFSA.

Chemical components of food can be a risk to public health in two ways – due to the presence of too much (toxicity) or due to presence of too little (inadequate nutrition). Food-associated chemical hazards (agricultural compound residues, dioxins, heavy metals like lead and mercury, natural toxins, certain vitamins and minerals) can represent both acute (single meal/day) and chronic (long term/monthly/yearly) risks to public health.

The ESR/NZFSA risk-based Chemical Food Safety Science Service aims to provide up-to-date information on the concentration of chemical contaminants and nutrients in our food supply, associated dietary intakes and assessments of potential risk.

The food chemical surveillance undertaken by ESR for the NZFSA should continue to confirm that New Zealand foods are generally very safe. However, in some instances it may identify potential issues that may lead to targeted follow up compliance monitoring, possible food recalls, review of food regulations, encouragement to industry to adopt safer food manufacturing processes, and/or appropriate advice to consumers, amongst other risk management/communication options.

An on-going commitment to risk-based chemical monitoring is important as it also enables chemical food safety trends to be identified, and the success of short and long-term risk management/communication strategies to be assessed. Risk-based monitoring of chemical hazards throughout the food chain will continue to be an important regulatory activity in New Zealand.

Projects included in this Science Service in 2005-2006 were:

- 2003-2004 New Zealand Total Diet Survey
- Food Residues Surveillance Programme
- WHO Global Environment Monitoring System/ Food
- Genetically Modified Food Analysis and Capability Development
- Fortification Overages of the Food Supply
- Allergenicity Capability Development and Consulting
- Bulk Food Shipping Contamination
- Monitoring of Sudan Dye
- Chemical Risk Profile for Mycotoxins in New Zealand Foods
- Scoping Malachite Green
- Risk Profile for Imported Ceramic and Enamel Human Food Containers
- Survey of Salt in Processed Foods
- Levels of Trans Fatty Acids in the New Zealand Food Supply

- Sulphite, Sorbate and Benzoate Dietary Exposure and Risk Assessment – Children (carried over from 2004-2005)

4.1 2003-2004 New Zealand Total Diet Survey (NZTDS)

The 2003-2004 New Zealand Total Diet Survey (NZTDS) was carried out for the NZFSA by ESR. Previous NZTDSs have been carried out in 1974-1975, 1982, 1987-1988, 1990-1991 and 1997-1998.

The 2003-2004 NZTDS sampled and tested foods for a representative range of chemical residues, contaminants and nutrient elements that reflect likely dietary exposure pathways for different classes of chemical hazards in the New Zealand food supply. The 2003-2004 NZTDS enables NZFSA to:

- Assess the status of certain compounds in the New Zealand food supply;
- Indicate any potential exposure concerns and target any necessary risk management or risk communication;
- Demonstrate trends in dietary exposure; and
- Make comparisons with exposure estimates derived in other countries.

The 2003-2004 NZTDS involved sampling 121 different foods, of which 110 represented at least 70% of the most commonly consumed food items for the majority of New Zealanders, and analysing these foods to determine the concentrations of agricultural chemical residues, selected contaminants (arsenic, cadmium, lead and mercury) and nutrient elements (iodine, iron, selenium and sodium). Changes to the food list since the 1997-1998 NZTDS included the addition of infant formulae and weaning foods, as well as other foods such as muffins, caffeinated energy drinks, flavoured milk, strawberries, grapes, and snack bars, to reflect changing dietary consumption. Foods were allocated into 12 food groups – Alcohol; Beverages, non-alcoholic; Chicken, eggs, fish and meat; Dairy; Fruits; Grains; Infant weaning foods; Nuts; Oils and fats; Spreads and sweets; Takeaways; and Vegetables. This was to enable comparison with previous NZTDSs and to identify food groups which were likely to contain specific agricultural compound residues, and contaminant or nutrient elements.

Two-weekly simulated typical diets using these 121 foods were derived mainly from food frequency and 24 hour diet recall data from the 1997 National Nutrition Survey for adults 15+ years and the 2002 Children's Nutrition Survey for 5-14 year olds (both commissioned by the New Zealand Ministry of Health). Data from recent studies were used to simulate typical diets for children younger than five years of age.

The two-weekly simulated typical diets were established for the following eight age-sex groups, three of which were established for the first time in the 2003-2004 NZTDS.

- 25+ year male (M),
- 25+ year female (F),
- 19-24 year young male (YM),
- 11-14 year boy (B), (new in 2003-2004)
- 11-14 year girl (G), (new in 2003-2004)
- 5-6 year child (C),
- 1-3 year toddler (T) and
- 6-12 month infant (I) (new in 2003-2004).

From these two-weekly diets, the weight of each individual food item consumed was determined for each age-sex group.

The 121 foods were, for the purpose of sampling, split into two groups – one comprising 63 national foods – and the other 58 foods sampled on a regional basis. National foods were defined as those that were either manufactured in one location and distributed throughout New Zealand, or they were imported and distributed nationally (such as bananas and sultanas). All national foods were purchased in supermarkets in Christchurch because the geographical region where national foods were purchased is presumed to have no bearing on the levels of agricultural compound residues, contaminant or nutrient elements in the product. Regional foods may potentially vary in their agricultural compound residue, contaminant or nutrient element levels, so regional foods were sampled in four centres – Auckland, Napier, Christchurch and Dunedin.

Foods sampled were aimed at being typical of what was available at the point of sale. All foods were bought at two different times of the year to provide a measure of seasonal variation. The sampling protocol used in the 2003-2004 NZTDS followed international best practice.

Approximately 4,440 different food samples were purchased in the 2003-2004 NZTDS. Most of these were composited to provide a total of 968 different food samples for elemental analyses, and 990 samples for agricultural compound residue analyses. As with the last three NZTDSs, all foods in the 2003-2004 NZTDS were prepared ready for consumption, prior to analysis. The analysis of the prepared samples was undertaken in accredited laboratories, using internationally-accepted methodologies and a number of quality control requirements (including blanks, duplicates, spike recovery and/or Certified Reference Materials, and control samples) were used to ensure the scientific robustness of results.

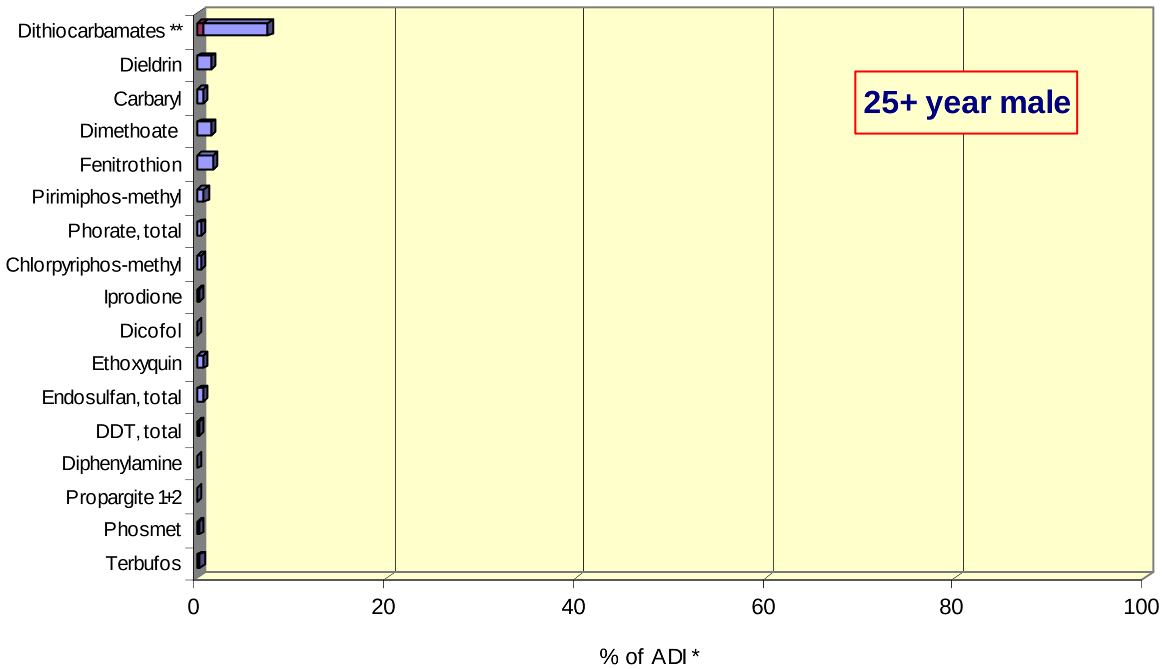
Agricultural Compound Residues in the 2003/04 NZTDS

Of the 990 food samples screened for 221 agricultural compound residues in the 2003-2004 NZTDS, 498 samples (50%) were found to contain detectable residues. This is lower than the percentage (59%) found in the 1997-1998 NZTDS. Residues of 82 different agricultural compounds were detected in the 2003-2004 survey.

Residues were detected in only 997 (0.5%) of the approximately 199,100 individual analytical agricultural compound residue results, compared with 1.4% in 1997-1998.

Estimated dietary exposures to agricultural compound residues for the eight age-sex group simulated typical diets in the 2003-2004 NZTDS were all well below the relevant Acceptable Daily Intake (ADI). Ninety per cent of these dietary exposures were less than 0.1% of the ADI. Of these, 66% had zero exposure because there were no detectable residues, and 24% of the residue exposures were between 0% and 0.1% of ADI. For the remaining dietary exposures, 5.2% were between 0.1 and 1% of ADI, 2.7% between 1 and 5% of ADI, and 0.5% between 5 and 20% of the ADI. Representative data for the dietary exposure of an adult New Zealand male to agricultural compound residues are shown in Figure 3.

Figure 3: **Estimated daily dietary exposures to agricultural compound residues for a 25+ year male in the 2003-2004 NZTDS**



The highest estimated dietary exposures were for dithiocarbamate (DTC) fungicides. For adults, these ranged from 0.6-8%, and for children/infants from 1.2-19% of ADI. The upper bound range represents a worst case conservative estimate as it is based on the lowest available DTC ADI (i.e. the most toxic) of 3 µg/kg body weight/day for thiram and ziram. The degree of overestimation could be as much as a factor of ten if all DTCs actually present were from the group with the highest ADI (30 µg/kg body weight/day, which includes mancozeb and metiram). Thiram, ziram, mancozeb and metiram are all registered for use in New Zealand and the internationally-accepted analytical methods employed in this survey are unable to differentiate which DTC is being detected. In addition, current DTC methodology is unable to differentiate DTCs from natural compounds in some vegetables (e.g. brassicas). Apparent residues on brassicas contribute approximately 43-51% of the total estimated exposure to DTCs for adults and 20-35% for infants/children. The actual dietary exposure is likely to be within the upper and lower bounds.

Contaminant Elements in the 2003-2004 NZTDS

The estimated weekly dietary exposures to **arsenic, cadmium, lead,** and **mercury** for the eight age-sex group simulated typical diets in this survey were all well within the Provisional Tolerable Weekly Intakes (PTWIs) set by the World Health Organization.

Foods in the 2003-2004 NZTDS analysed for total **arsenic** had concentrations consistent with documented international levels. Fish products (fresh fish, canned fish, battered fish, mussels and oysters) contributed 90% of weekly total arsenic exposure for the young male diet and 85% for the toddler diet. International studies have demonstrated that most (>90%) of the arsenic present in fish is in the relatively non-toxic organic form.

Using the conservative assumptions that 10% of total arsenic in fish/seafood is inorganic, and that 100% of total arsenic in all other foods is inorganic, the weekly dietary exposures to inorganic arsenic for the eight age-sex groups of the 2003-2004 NZTDS were all less than 17% of the PTWI for inorganic arsenic.

Cadmium estimated weekly dietary exposures in New Zealand are strongly influenced by the inclusion of oysters in the simulated typical diet (19-24 year young male – 1.8 µg/kg body weight/week including oysters, 1.3 excluding oysters).

Oysters, breads and potatoes were identified as the major sources of dietary cadmium. These all have cadmium concentrations higher than those generally reported overseas.

Nevertheless, weekly dietary exposure to cadmium for the 19-24 year young male (diet including two-three oysters per fortnight) is 26% of the PTWI, and well down on the 40% of the PTWI in 1997-1998 NZTDS. With oysters excluded from the simulated diet, the weekly dietary exposure to cadmium for the 19-24 year young male drops from 24% of the PTWI in 1997-1998 to 18% of the PTWI in 2003-2004.

The other dietary exposures to cadmium in the 2003-2004 NZTDS range from a low of 20% of the PTWI for the 11-14 year girl to 37% for the 5-6 year child and 1-3 year toddler. (The non-adult simulated typical diets do not include oysters.)

Cadmium dietary exposure in the 2003-2004 NZTDS for an adult male (diet including oysters) are below those of the Republic of Korea, similar to those of the Czech Republic, and above those of Australia, the USA, the UK, France, and the Basque Country. If oysters are excluded from the diet, the 2003-2004 NZTDS exposures to cadmium for the 25+ year male are then below or similar to all countries, except France.

Lead estimated weekly dietary exposures have again reduced for all age-sex groups since the 1997-1998 NZTDS, to 3.8% of the PTWI for 19-24 year young male (compared with 103% in 1982), and 12% of the PTWI for 6-12 month infants. The continued decrease in dietary lead exposures can probably be attributed to the complete removal of lead additives from retail petrol since 1996.

The individual foods contributing to dietary lead exposure were spread fairly evenly over the food groups and reflect the ubiquitous environmental presence of residual lead in New Zealand.

Almost all foods in the 2003-2004 NZTDS had similar or lower levels of lead than in 1997/98, but for one marked exception. The 2003-2004 NZTDS identified a major lead contamination episode in the New Zealand food supply, initially found in baby food (0.8 mg/kg), but traced back to cornflour (23 mg/kg lead). This resulted in food recalls in New Zealand, Australia and Fiji.

The 2003-2004 NZTDS lead exposure for an adult male (0.9 µg/kg bw/week) is one of the lowest when compared to Australia (1.6), the USA (1.0), France (1.9), the Czech Republic (3.0), and the Basque Country (2.9). It is more than an order of magnitude below exposures reported for the Republic of Korea (21.2) and China (13.8).

Mercury estimated weekly dietary exposures for all age-sex groups were 26% or less of the PTWI for total mercury, and 86% or less of the PTWI if all assumed to be methylmercury.

Fish products contributed 74% of the dietary mercury exposure for a young male and 65% for a toddler.

Estimated weekly dietary exposure to mercury for a young male in the 2003-2004 NZTDS (0.74 µg/kg bw/week) was almost identical to the 1997-1998 NZTDS (0.73), despite a rise in fish/seafood consumption in 2003-2004 diet (250 g/week) compared to 1997-1998 (175 g/week).

Nutrient Elements in the 2003/04 NZTDS

The **iodine** content of most foods was less than 0.05 mg/kg. There were three foods with particularly elevated iodine content, namely a brand of soy milk (9.14 mg/kg), mussels (3.34 mg/kg) and oysters (1.38 mg/kg). The level in the soy milk was unexpected and unacceptably high. Soy milk normally has less than 0.01 mg/kg iodine, and elevated levels were due to the use of seaweed in the formulation of one particular product. As a consequence of the NZTDS findings this product was reformulated by the manufacturer.

The estimated mean daily intakes of iodine in the 2003-2004 NZTDS were significantly lower than the Recommended Daily Intake (RDI) for all age-sex groups. Iodine intake varied from only 40% of the RDI for a 25+ year female, to 57% of the RDI for a 25+ year male.

It should be noted that the dietary iodine intakes of this survey (and any previous NZTDSs) are likely to be underestimated because discretionary salt used during cooking or at the table for taste was not considered.

A combination of dairy foods and other animal sources (eggs, mussels, fresh fish and oysters) provided the majority of the iodine in the diet of a 25+ year male and female, 19-24 year young male, and 11-14 year boy and girl. Dairy foods make the most significant contribution to iodine intake for a 1-3 year toddler (67%). Intake of iodine for a 6-12 month infant is dominated by levels in infant weaning foods.

Mean daily intakes of iodine in New Zealand have steadily declined over the past 20 years and are low compared with intakes in the UK, Denmark and The Netherlands.

The concentration of **iron** in most foods is less than 50 mg/kg. The highest concentration of iron was found in yeast extract and lambs liver at 446 and 435 mg/kg respectively. A number of cereal products, and mussels and oysters, had maximum iron levels above 100 mg/kg.

Mean daily intakes of iron for a 25+ year male, 19-24 year young male, and 11-14 year boy and girl are between the RDI and upper intake limit. Intake for a 25+ year female, 5-6 year child, 1-3 year toddler and 6-12 month infant are below the RDI, with the lowest intake seen for a 25+ year female, who on average is consuming only 51% of the RDI of iron.

Grains and red meat (beef and lamb) are important contributors to iron intake for a 25+ year male and female, 19-24 year young male, and 11-14 year boy and girl. Wheat biscuit cereals, yeast extract, white bread and cornflakes are the major contributors to intake of a 1-3 year toddler, and infant weaning foods, yeast extract and wheat biscuit cereals are the major contributing foods for a 6-12 month infant.

Mean iron intake for a 25+ year female has changed little over the past 20 years, even with the recent permitted fortification of grain products, while iron intake for a 19-24 year young males has decreased by approximately 25% during the past ten years.

Calculated daily dietary intakes of **selenium** for all age-sex groups of the 2003-2004 NZTDS meet, or are slightly below, the RDI. Across each population group selenium intakes have been steady over a 20-year period. By international standards, intake of selenium in New Zealand falls within the middle range.

Seafood, chicken, eggs, breads and grain products provide the majority of selenium in the diets of all age-sex groups included in the 2003-2004 NZTDS, except for the 6-12 month infant, for whom infant weaning foods contribute nearly 30%.

The selenium content of breads suggests a geographical difference, with South Island (Christchurch and Dunedin) breads containing less selenium than North Island (Auckland and Napier) breads.

The concentration of **sodium** in the 121 foods of the 2003-2004 NZTDS ranged from <10 to 42,000 mg/kg, with the highest level measured in a yeast extract. Higher sodium concentrations are found in processed than unprocessed foods. For example, the mean concentration of sodium in pork is 838 mg/kg, compared with 15,250 mg/kg in bacon.

Mean daily sodium intakes are significantly above the adequate intake for all age-sex groups and exceeded the upper intake limits for a 25+ year male, 19-24 year young male, 11-14 year boy and girl, 5-6 year child, and 1-3 year toddler. For the 19-24 year young male, intakes were 157% of the upper intake limits.

The single greatest contributor to sodium intake is bread, accounting for 15-27%, followed by processed meats (bacon, ham, corned beef and sausages), contributing 10-14% of total sodium intake. Processed grain products collectively account for 33-48% of sodium intake.

The sodium intake estimates in the 2003-2004 NZTDS do not include the use of discretionary salt, added at the time of cooking, or at the table for taste, and it has been estimated that this could add up to an additional 25% to total sodium intake.

Estimated sodium intake has decreased for a New Zealand 25+ year male and female, 19-24 year young male and a 1-3 year toddler by 8 to 17% for the period 1987 to 2003.

The mean daily sodium intake by New Zealand age sex groups is higher than those for the UK, France and the USA.

Vannoort RW, Thomson BM. (2005). 2003-2004 New Zealand Total Diet Survey. Agricultural Compounds, Selected Contaminants and Nutrients. ESR Client Report FW0549.Christchurch: ESR.

Vannoort RW, Thomson BM. (2005). Auxiliary Data – 2003-2004 New Zealand Total Diet Survey. Agricultural Compounds, Selected Contaminants and Nutrients. ESR Client Report FW0561. Christchurch: ESR.

All these reports have been published on the New Zealand Food Safety Authority website (http://www.nzfsa.govt.nz).

4.2 Food Residue Surveillance Programme (FRSP)

During the 2005-2006 year, reports from FRSP activities carried out during 2003-2004 and 2004-2005 were completed.

FRSP 2003-2004:

The 2003-2004 New Zealand Multi-Residue Survey (NZMRS) was undertaken as a pilot survey for an on-going agricultural compound food residue surveillance programme. NZFSA identified a need for data to verify the effectiveness of regulatory measures on the use of agricultural compounds and resulting residues, but had limited information in this area. It had been 12 years since the last plant products commodity pesticide residue survey.

Primary plant and related products were selected on the basis of likely residues, lack of NZFSA information about actual residues, food consumption and other data sources. In the first year of this programme, seven foods were sampled (number of samples per food type in brackets):

- bananas (24),
- broccoli (46),
- grapes, table (72),
- lettuce (49),
- potatoes (50),
- tomatoes (74), and
- wine (33).

Foods sampled were from a range of production methods, including organic, and included domestic and imported product when available at time of sampling.

Foods were sampled at each of three locations (Auckland, Palmerston North, and Christchurch) at two different times of year.

All 348 food samples were analysed, as received, by a multi-residue agricultural compound screen covering 215 compounds, including organochlorine and organophosphorus pesticides, fungicides, herbicides and plant growth regulators.

Out of a total of 74,820 agricultural chemical/food results, 254 (0.3%) had detectable residues. Of these, there were a total of 31 detectable agricultural chemical residues found in all bananas, four in broccoli, table grapes (90), lettuces (32), potatoes (15), tomatoes (67), and wine (15).

Nine agricultural chemical residues accounted for 158 (62%) of the 254 different residue/food results detected. Those detected most were iprodione (37), chlorpyrifos (25), captan (20), endosulfan (19), pyrimethanil (14), procymidone (13), imazalil (10), propham (10) and chlorothalonil (10). A total of 37 different agricultural chemical residues were detected out of 215 screened for.

Of the 348 food samples analysed, the 99 imported foods (bananas, and some grapes and wine) had 62 samples (63%) with detectable residues, whereas the 249 domestic foods (broccoli, lettuces, potatoes, tomatoes, and some grapes and wine) had 77 samples (31%) with detectable residues.

The one hundred and thirty nine (139) different food samples with detectable agricultural chemicals out of the 348 analysed in total is equivalent to 40%. This is similar to the 42% for the European Union and 38% for the United States in their pesticide residue monitoring programmes for the same commodities (excluding wine). Such comparisons, however, should be made with due caution and recognising the differences in the respective monitoring programmes.

Of the 139 different samples with detectable residues, 19 were banana, broccoli (3), grapes (42), lettuce (17), potato (10), tomato (35), and wine (13).

The individual samples with the most different residues were grapes (two samples each with five different residues, three with four, and seven with three), lettuce (six samples each with three different residues), and tomato (one with five, two with four, and four with three).

Nine individual food samples (2.6%) exceeded the maximum residue limit (MRL) out of the 348 samples in the survey. This is comparable to the 1.7% for the European Union and 1.6% for the United States in their pesticide residue monitoring programmes for the same commodities (excluding wine). Of the nine samples, one exceeded the MRL where one was specifically defined (methamidiphos in lettuce 0.64 mg/kg; New Zealand MRL for leafy vegetables of 0.5 mg/kg). The other eight were all in excess of the default New Zealand MRL of 0.1 mg/kg, and for imported grapes and bananas also had no relevant Codex MRL, so all could be considered 'technical non-compliances'. They were azoxystrobin 0.15 mg/kg in New Zealand lettuce; cyprodonil in imported grapes (0.15, 0.18 and 0.28 mg/kg); iprodione in imported bananas (0.11, 0.45, 0.57 mg/kg); and pyrimethanil in New Zealand tomato (0.92 mg/kg).

FRSP 2004-2005:

The 2004-2005 New Zealand Food Residue Surveillance Programme (NZFRSP) is part of an on-going agricultural compound food residue surveillance programme initiated in 2003-2004 by the New Zealand Food Safety Authority (NZFSA) to verify the effectiveness of regulatory measures on the use of agricultural compounds and resulting residues.

Primary plant, animal, seafood and related products were selected on the basis of likely residues, lack of NZFSA information about actual residues, food consumption and other intelligence. In this second year of the programme, nine foods were sampled (number of samples per food type in brackets):

- lettuce (48),
- oranges (48),
- peanuts (48)
- pears (48),
- pork, imported (50),
- potatoes (48),
- prawns, imported (48),
- strawberries (47), and
- taro (48)

The seven plant-based food commodities were sampled from retail outlets at each of four locations (Auckland, Palmerston North, Christchurch and Dunedin) at two different times of year.

The 335 plant-based food samples were analysed, as received, by a multi-residue agricultural compound screen covering 215 compounds, including organochlorine and organophosphorus pesticides, fungicides, herbicides and plant growth regulators.

Out of a total of 72,025 agricultural chemical/food results, 191 (0.3%) had detectable residues. Of these, there were a total of 23 detectable agricultural chemical residues found in all lettuces, 83 in oranges, peanuts (3), pears (32), potato (7), strawberries (42), and taro (1).

Three agricultural chemical residues (captan, imazalil and chlorpyrifos) accounted for 110 (58%) of the 191 different residue/food results detected. Those residues detected most were captan (46), imazalil (40) and chlorpyrifos (24), chlorothalonil (12), carbaryl (8), diazinon (8), endosulfan sulphate (8) and propham (5). A total of 30 different agricultural chemical residues were detected out of 215 screened for.

Of the 335 plant-based food samples analysed, the 155 imported foods (all peanuts, taro, and some of the oranges, pears and strawberries) had 42 samples (27.1%) with detectable residues, while the 180 domestic foods (all lettuces, potatoes and some oranges, pears and strawberries) had 84 samples (46.6%) with detectable residues.

The one hundred and twenty-six (126) different plant-based food samples with detectable agricultural chemicals out of the 335 analysed in total is equivalent to 38%.

Of the 126 different plant-based food samples with detectable residues, lettuces had a total of 15 residues detected, oranges (46), peanuts (3), pears (28), potatoes (6), strawberries (27) and taro (1).

The individual samples with the most different residues were lettuces (one sample with six different residues), oranges (five samples each with three different residues), pears (one with three) and strawberries (one with four, and three with three).

Four individual food samples (1.2%) exceeded the maximum residue limit (MRL) out of the 335 plant-based foods in the 2004-2005 NZFRSP. Of the four samples, two exceeded the MRL where one was specifically defined (imazalil in New Zealand oranges 6.3 mg/kg; New Zealand MRL for citrus fruits of 5 mg/kg; and procymidone in New Zealand lettuce 3.2 mg/kg; New Zealand MRL for leafy vegetables of 1 mg/kg). The other two results were both in excess of the default New Zealand MRL of 0.1 mg/kg, and so could be considered 'technical non-compliances'. They were acephate 0.27 mg/kg in New Zealand strawberries; and tolylfluanid 0.34 mg/kg, also in New Zealand strawberries.

The prawns were sampled from a range of different consignments at the port of importation (Auckland) and subsequently analysed for chloramphenicol and metabolites of nitrofuran. Chloramphenicol was not detected in any of the prawn samples tested as part of the 2004-2005 NZFRSP. Nitrofuran metabolites were detected in six (12.5%) of the tested prawn samples. The concentrations of nitrofurans did not exceed the default MRL for agricultural compounds.

The imported pork was sampled from different meat processors located throughout New Zealand in two batches. Antibiotics, including sulphonamides, were not detected in any of the imported pork samples tested as part of the 2004-2005 NZFRSP.

Vannoort R. (2005) New Zealand Multi-residue Survey. Consolidated results report for 2003-2004. ESR Client Report FW0496. Christchurch: ESR.

Vannoort R, Thomson B. (2006) New Zealand Food Residue Surveillance Programme. Consolidated results report for 2004-2005 for plant-based foods. ESR Client Report FW05126. Christchurch: ESR.

Vannoort R, Thomson B, Gaw S. (2005) New Zealand Food Residue Surveillance Programme. Antibiotics and sulphonamides in imported pork, nitrofurans and chloramphenicol in imported prawns. Consolidated results report for 2004-2005. ESR Client Report FW05125. Christchurch: ESR.

4.3 WHO Global Environment Monitoring System/ Food

The joint UNEP/FAO/WHO Food Contamination Monitoring and Assessment Programme, commonly known as GEMS/Food, was initiated in 1976 and is a major component of the Global Environmental Monitoring System (GEMS). Now administered by WHO, the GEMS umbrella also encompasses health-related monitoring of air, water, and human tissues and fluids. The main objectives of the GEMS/Food programme are:

- To collect data on levels of certain chemicals in individual foods and in total diet samples and to evaluate these data, review trends and produce and disseminate summaries, thus encouraging appropriate food control and resource management measures.
- To obtain estimates of the intake via food of specific chemicals, with a view to combining these data with those from other sources and thus enabling the total intake of the contaminant to be estimated.
- To provide technical co-operation with the governments of countries wishing to initiate and strengthen food contaminant monitoring programmes.

- To provide the joint FAO/WHO Codex Alimentarius Commission with information on the level of contaminants in food to support and accelerate its work on international standards for contaminants in foods.

Since 1978, participating organisations in approximately 70 countries have submitted information under the GEMS/Food programme on estimated daily intakes and levels in foods for a list of priority food contaminants. New Zealand became involved in the GEMS/Food programme in 1978 when the, then, Food and Nutrition Branch, New Zealand Department of Health was appointed a designated Collaborating Centre for Food Contaminant Monitoring. New Zealand, through the efforts of staff at ESR and the NZFSA are now a leader in initiatives related to the GEMS/Food programme.

During the 2005-2006 year the New Zealand Collaborating Centre audited New Zealand data submitted during the previous project year and available on the Internet (see http://sight.who.int/). All New Zealand data were found to present and correct.

The New Zealand Collaborating Centre continues to contribute monitoring data to GEMS/Food on a regular basis. Data contributed this year included:

- Concentration data on pesticides from the 2003/2004 New Zealand Total Diet Survey (completion of work begun in 2004-2005);
- Concentrations of pesticides in selected commodities from the 2004-2005 Food Residue Surveillance Programme;
- Concentration data from import monitoring of aflatoxins in nuts and polenta, metals (cadmium, copper and selenium) in crustaceans, and chloropropanols in soy sauce;
- Concentrations of mercury in New Zealand fish;
- Concentrations of acrylamide in New Zealand foods;
- Dietary exposure estimates for pesticides and selected contaminant metals from the 2003-2004 New Zealand Total Diet Survey
- Dietary exposure estimates for the preservatives, sulphite, sorbate and benzoate, for New Zealanders 5-15 years of age.

During 2005-2006 ESR again negotiated with WHO to expand the range of food contaminants in the GEMS/Food database to accommodate further New Zealand data and provide a fuller representation of the status of the New Zealand food supply.

Further discussions were held during the year with various groups within the NZFSA concerning accessing a wider range of food contaminant data for submission to WHO. Areas discussed were residues in animals, residues in dairy products, and a range of chemical contaminants in imported foods.

An annual report for the 2005-2006 year and a proposed work plan for the 2006-2007 have been drafted for submission to the WHO Regional Office for the Western Pacific in Manila.

4.4 Genetically Modified Food Analysis and Capability Development

Stakeholder concern over the presence of genetically modified material in foods continues to be an issue within both New Zealand and the International Community. Current Food Standards Australia New Zealand (FSANZ) labeling standards require compliance by notification of the presence of GM components present in foods if above certain levels. The NZFSA has a surveillance/monitoring programme in place to ensure compliance with labeling requirements. To support this it is necessary to have a robust testing system available for detection of genetically modified material in complex food matrices. ESR currently has the only IANZ Accredited Laboratory for detection of GM components in foods in New Zealand.

The report covers the work undertaken by ESR during the period July 2005 to June 2006.

The contracted project was designed to:

(i) *Provide analyses to assist the NZFSA in monitoring compliance with the FSANZ labeling standard for Genetically Modified Food.*

- No samples were provided by or authorized by the NZFSA for analysis during the project period.

As no samples were provided for analysis during the contract period the focus of the work undertaken was in capability maintenance and development.

(ii) *Enable the ongoing development of optimized methodologies and capability for the detection of genetically modified material within complex food matrices.*

Capability maintenance and development was addressed in four areas:

- ESR continued to perform at a satisfactory level in international proficiency programmes for the detection of GM ingredients in food.
- Work was continued in the research project “Cooking Genes”, leading to the development of assays to determine the effect of cooking on DNA stability.
- TaqMan assays were developed to detect GM components in cooked potato tissue.
- The TaqMan assay system was tested for robustness to detect GM material in a range of food products. Whilst promising for the detection of the 35S promoter element more development of the assay is needed to detect the nos-3’terminator in GM products.

Podivinsky E. (2006) Genetically modified food analysis and capability development. ESR Client Report FW0674. Christchurch: ESR.

4.5 Fortification Overage of the Food Supply

The aim of the current project was to assess the levels of vitamin A, vitamin D and calcium in fortified foods and to compare levels to those claimed on product labels to underpin the development of food standards relating to nutrient fortification.

Approximately 290 samples from seven different food groups were analysed for added vitamin A, vitamin D or calcium. Samples were purchased between November 2005 and May 2006 from Christchurch or Auckland retail outlets.

Vitamin A content was determined using a solvent extraction and analysis by reverse phase high performance liquid chromatography (HPLC) with fluorescence detection. The inter-sample variability for 5 batches of 22 foods, as measured in terms of CV (coefficient of variation), was 0-42%. Pre-vitamin D and vitamin D was extracted after saponification, purification by semi-preparative HPLC and analysis by isocratic, reversed-phase HPLC. The inter-sample variability for 5 batches of 18 foods, as measured in terms of CV, was 1-46%. Calcium was measured by atomic emission spectroscopy following ashing and dissolution in nitric acid. The inter-sample variability for 5 batches of 18 foods, as measured in terms of CV, was 2-47%.

In assessing the data, an overage or underage was defined as being where the label claim did not correspond to the measured value after making an allowance for the measurement uncertainty associated with this value.

Vitamin A concentrations were 11-100% below the label claim in 41% of the products tested (9/22) and exceeded the label claim in 32% (7/22) of products with overages of 18-44%. Comparisons of label claim and actual vitamin A concentrations are shown in Figure 4. High consumption of the product with the maximum vitamin A overage would result in an intake of up to 27% of the upper level of intake (UL).

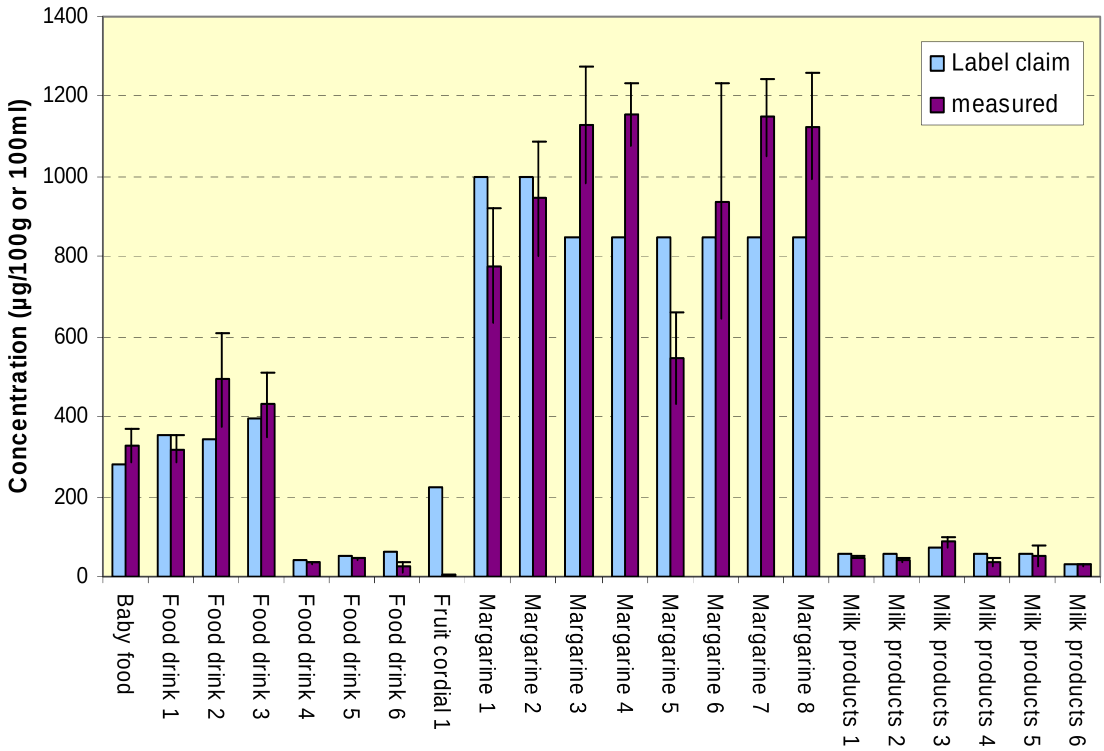
Vitamin D concentrations were 47-68% below the label claim in 28% of the products tested (5/18) and exceeded the label claim in 39% (7/18) of products with overages of 25-70%. High consumption of the product with the maximum vitamin D overage would result in an intake of up to 4% of the UL.

Calcium concentrations were 7-18% below the label claim in 11% of the products tested (2/18) and exceeded the label claim in 39% (7/18) of products with overages of 26-79%. High consumption of the product with the maximum calcium overage would result in an intake of up to 77% of the RDI or 8% of the UL

A total of 27% (16/58) of the foods sampled contained less fortificant than claimed, based on the criteria applied in this assessment. Consumers of these products are ingesting less of the added nutrients than they would believe, based on label claims.

A total of 36% (21/58) of the foods sampled contained more fortificant than claimed. None of the selected foods fortified with either vitamin A, vitamin D or calcium appear to present a realistic hazard of a consumer exceeding the UL of any of these nutrients.

Figure 4: Measured concentrations of vitamin A compared with label claim (Errors bars are ± 1.2 x standard deviation)



All analytical measurements have associated uncertainty arising from sampling, the analytical method and the manufacturing technique. For standard setting, consideration may be given to defining a range around the label claim that takes measurement uncertainty into account.

Thomson BM. (2006) Fortification overages of the food supply: Vitamin A, vitamin D and calcium. ESR Client Report FW0637. Christchurch: ESR.

4.6 Allergenicity Capability Development and Consulting

The allergen capability project aims to develop testing capability to support the application of Australia New Zealand Standard 1.2.3, requiring mandatory declaration of certain allergenic materials in foods.

Activity under this project during 2005-2006 included:

- Provide consulting support for NZFSA allergen initiatives.
- Provide New Zealand input to Allergy Forum projects, particularly Threshold and Testing
- Continue to develop allergen testing capability.
- Enrol in and participate in interlaboratory testing programme (e.g. FAPAS)
- Establish performance parameters for Monier-Williams sulphur dioxide test, to support a regulatory limit for labelling of 10 ppm.
- Continue to monitor literature for options for testing for fish and crustacea in processed foods.

Little call was made on ESR under the first two listed activities (consulting and Allergen Forum projects) and activity focused on capability development during the 2005-2006 year.

A test kit for detection of sesame protein was evaluated. The kit was found to be sensitive for the presence of sesame protein, but was not reliable for quantitative determination and was subject to potentially significant cross-reactions with other seed types, such as poppy and sunflower.

The peanut kit evaluated during the 2004-2005 project year (Tepnel) was tested on a wider range of matrices and found to perform acceptably across a range of challenging matrices (chocolate, ice cream).

The egg testkit evaluated during 2004-2005 demonstrated poor detectability for heat-treated protein. A kit from another manufacturer (Tepnel) was assessed and found to give improved, but incomplete recovery of heat-treated egg protein.

ESR participated in two rounds of the FAPAS inter-laboratory comparison programme for allergens during 2005-2006 (gluten in infant food, peanut in chocolate) and achieved satisfactory performance in both rounds.

Further investigations were carried out on the Monier-Williams method for determination of sulphur dioxide in foods. A protocol was established that gave satisfactory precision and accuracy for determination of sulphur dioxide in liquid samples to the regulatory limit for mandatory labelling of 10 mg/kg. Improved protocols for solid foods demonstrated satisfactory precision to detect sulphur dioxide at 10 mg/kg, but the accuracy of the method at low concentration was generally not satisfactory (30-50%).

Little new science has emerging during 2005-2006 to support development of robust general methods for the detection of fish protein in processed foods. Methods published tend to be fish species specific. Some studies have confirmed parvalbumin as the major fish allergen, while other studies did not detect parvalbumin in some allergenic fish species.

Cressey P, Jones S. (2006) Food allergens capability development. Summary of investigations 2005-2006. ESR Client Report FW0649. Christchurch: ESR.

4.7 Bulk Food Shipping Contamination

This project was discontinued early in 2005-2006.

4.8 Monitoring of Sudan Dye

Sudan I-IV and Para Red are potentially carcinogenic dyes that have occasionally been detected in foods, such as spices and oils. They are not permitted food additives.

During 2005-2006, 200 samples of spices and oils were analysed for Sudan I-IV and Para Red. Sudan I (35 mg/kg) and Sudan IV (40 mg/kg) were detected in one sample of hot chilli powder. No other sample contained detectable quantities of these dyes.

4.9 Chemical Risk Profile for Mycotoxins in New Zealand Foods

The purpose of a Risk Profile is to provide contextual and background information relevant to a food/hazard combination so that risk managers can make decisions and, if necessary, take further action. Risk Profiles include elements of a qualitative risk assessment, as well as providing information relevant to risk management. Risk profiling may result in a range of activities, e.g. immediate risk management action, a decision to conduct a quantitative risk assessment, or a programme to gather more data. Risk Profiles also provide information for ranking of food safety issues.

The Risk Profile for mycotoxins in New Zealand foods contains individual risk profiles for the fungal toxins (mycotoxins) likely to be of greatest concern in New Zealand: aflatoxins, ochratoxin A, trichothecenes (nivalenol, deoxynivalenol, T2 toxin and HT2 toxin), fumonisins, zearalenone, ergot alkaloids and patulin. The information in the risk profiles was also used to provide a qualitative ranking of the risks to the New Zealander consumer due to mycotoxin exposure.

The following conclusions were reached:

- There is consistent evidence to support a causal link between chronic aflatoxin exposure and serious human disease (primary liver cancer). Exposure levels in New Zealand are likely to represent a very low level of risk, although better information on the contribution of maize to dietary aflatoxin exposure would decrease the uncertainty around this conclusion.
- There is some evidence to support a link between human kidney disease and exposure to ochratoxin A (OTA), however, further work is required to establish a causal relationship. Dietary exposure to ochratoxin A in New Zealand may approach tolerable daily intake levels and further investigation, particularly of the occurrence of ochratoxin A in bread and other wheat products, would help to clarify the level of exposure of New Zealand consumers.
- There is little evidence that the trichothecenes T2/HT2 toxin occur in New Zealand or Australian cereal crops. Confirmation of this observation would allow attention to be focused on other issues.
- There is very good evidence that trichothecenes are able to cause outbreaks of gastrointestinal disease in humans. Current New Zealand exposure estimates appear unreasonably low compared to estimates made in Europe, where crop contamination levels appear to be similar. Some European exposure estimates approach the tolerable daily intakes and it would seem prudent to continue some New Zealand focus on this issue, particularly the potential for trichothecene contamination of wheat and wheat-based products.
- While there is an increasing body of information linking fumonisin exposure to serious human diseases, there is virtually no information on the exposure of New Zealanders to these mycotoxins. While the fungal species that produce fumonisins have only rarely been reported in New Zealand, our considerable level of cereals imports mean that potential for dietary exposure still exists.
- Evidence linking zearalenone exposure to human disease states is fragmentary and inconsistent. However, the exposure of New Zealanders to zearalenone may be significant when compared to tolerable daily intakes. Further investigation of the role of wheat-based foods in zearalenone dietary exposure in New Zealand would help to clarify this issue.

- Ergotism represents a serious and real human health risk, however, in the context of current agricultural and food manufacturing practices, the dietary risk appears to be extremely low.
- While toxicological experiments have raised concerns about patulin exposure, there is no evidence linking patulin exposure to human disease. However, high levels of patulin contamination are indicative of poor manufacturing practice and a level of ongoing monitoring is probably justified.

Ranking of risk across different mycotoxins will involve a degree of subjectivity, as there is no absolute measure for the relative seriousness of different health effects. However, the proximity of estimates of OTA exposure to tolerable daily exposure limits suggests that more work should be carried out in this area.

The seriousness of the health outcomes resulting from aflatoxin exposure and the weight of evidence supporting a casual role for aflatoxins with respect to primary liver cancer suggest that further work on sources of dietary exposure (e.g. maize) in New Zealand should be carried out.

Cressey P, Thomson B. (2006) Risk profile: Mycotoxins in the New Zealand food supply. ESR Client Report FW0617. Christchurch: ESR.

4.10 Scoping Malachite Green

Malachite green is a blue-green dye which has a long history of successful use as an antiparasitic and antimycotic substance for treatment of fish diseases. In recent years most countries have prohibited its use in fish farming because of concern about the safety of residues of malachite green and its metabolite leucomalachite green, which may be mutagenic or carcinogenic. The NZFSA has requested background data pertaining to the various non-aquaculture uses of malachite green in New Zealand to help achieve a position where assurances can be given that malachite green is not used in fish farming in New Zealand.

Malachite green products are used as therapeutic agents for aquarium fish in New Zealand. Despite the significant number of similar competing products (at least six), the total annual consumption of malachite green for this purpose is likely to be small (less than 5 kg). Use in laboratories (mainly as a stain for microbiology and histology) is also small (annually less than 10 kg). The only other significant use identified is the pulp and paper industry and is comparatively large (300 kg in the last year).

At present Customs records of malachite green imports can not be accessed by NZFSA. This needs to be rectified if a system of tracking of users is to be considered.

Mitchell J. (2006) Malachite green usage in New Zealand. ESR Client Report FW0608. Auckland: ESR.

4.11 Risk Profile for Imported Ceramic and Enamel Human Food Containers

Glazed or enamelled surfaces on food contact materials may contain a wide range of metals, including the toxic elements antimony, cadmium and lead. Improper formulation, inadequate firing or subsequent wear of the food contact surface may result in these metals being released into acidic foods.

Prevalence of unacceptable levels of antimony release from imported enamelware has not been reported in New Zealand. Reports of antimony poisoning due to enamelware are extremely rare worldwide. The symptoms of antimony poisoning are generally not severe and recovery is rapid and complete.

Prevalence of unacceptable levels of cadmium and lead release from imported ceramic and enamelware is low and comparable to rates reported overseas. Most non-compliant product originates from China. However, most of the ceramic and enamelware imported into New Zealand is from China.

National disease surveillance in New Zealand has not identified any cases of metal poisoning associated with food contacting ceramic or enamelware. Two case reports of lead poisoning in New Zealand, due to beverages stored on ceramicware jugs, were identified, but the most recent was 30 years ago.

All countries reviewed (New Zealand, Australia, USA, Canada, EU, Japan) regulate the release of cadmium and lead from glazed ceramicware. Regulation of enamelware is less common. Application of regulations to imports varies from country to country, with New Zealand's regime appearing to be one of the more stringent.

Cressey PJ. (2006) Risk profile: Lead, cadmium and antimony from imported ceramic and enamelware. ESR Client Report FW05110. Christchurch: ESR.

4.12 Survey of Salt in Processed Foods

Key data gaps for the salt (sodium chloride) concentration of processed foods were filled through the analysis of 21 targeted foods, to augment existing data from the 2003/04 New Zealand Total Diet Survey and the New Zealand Food Composition Database. Analyses were carried out for the sodium component of salt.

Concentration information from these three sources was consolidated into a database of sodium concentrations in 58 processed foods and used as the basis to estimate the intake of non-discretionary salt for seven sub populations. Consumption information for 25+ year males, 25+ females, 19-24 young males and 19-24 young females was obtained from the 1997 National Nutrition Survey. Intakes of salt for 11-14 year boys, 11-14 year girls and children 5-6 years were estimated from consumption information in the 2002 National Children's Nutrition Survey.

Mean and percentile salt intakes from processed foods are summarised in Table 2. Intake data was right skewed for each population group with most respondents consuming less than the mean for that population group. If salt is used as a vehicle of iodine fortification, the range and distribution of the salt intake will impact on iodine intakes.

Table 2: Dietary salt exposure estimates for New Zealand population subgroups

Age-Gender group	25+ year Male	25+ Female	19-24 Male	19-24 Female	11-14 Male	11-14 Female	5-6 Child
Estimated Daily Dietary Salt Intake (g/day)							
Mean	5.9	3.9	6.9	5.1	5.2	4.2	3.5
Median	4.6	3.1	5.5	3.7	4.6	3.8	3.3
5th percentile	0.9	0.4	0.5	0.4	1.1	0.7	0.9
95th percentile	14.0	9.6	14.7	12.7	12.0	9.6	7.8

A wide range of processed foods were found to contribute to salt intake with bread clearly accounting for the greatest contribution across each of the 7 sub-populations (35 to 43% of total salt intake). Other foods that contributed 2% or more to salt intake and were common across the age groups were sausage, meat pies, pizza, instant noodles (except for the 25+ males) and cheese (except for the 5-6 year old children). Foods that accounted for 2% or more for specific age-gender groups were:

- 25+ year old males; bacon, margarine, corned beef, ham and butter
- 25+ year old females; cake, margarine, muffin, bacon, soup, butter, corned beef and yeast extract
- young males; hamburgers, tomato sauce and pasta sauce
- young females; bacon, tomato sauce, corned beef, soup, margarine and flavoured snacks
- 11-14 boy; ham, biscuits, tomato sauce, flavoured snacks, corned beef, and potato crisps
- 11-14 girl; flavoured snacks, biscuits, ham, potato crisps, corned beef, and tomato sauce and
- children 5-6 years; plain biscuits, flavoured snacks and potato chips, ham, tomato sauce and canned spaghetti.

New Zealand and Australia are currently considering mandatory fortification of iodine as a risk management option to redress the issue of low iodine intake. Appropriate food vehicles and levels are yet to be determined but the salt survey provides useful directions if salt fortification is considered.

Thomson B. (2006) Survey of salt in processed foods. ESR Client Report FW0601. Christchurch: ESR.

4.13 Levels of Trans Fatty Acids in the New Zealand Food Supply

This project has conducted a survey of selected New Zealand foods to determine moisture and fat content, and fatty acid profiles. The principal objective was to provide data on *trans* fatty acid content to support decisions regarding labelling.

Samples were chosen on the basis of several criteria:

- Information about major fat sources in the New Zealand diet was reviewed;
- Exclusion of samples containing solely animal fats with naturally occurring *trans* fatty acids;

- Results from samples taken for a concurrent survey of *trans* fatty acids in foods in New South Wales;
- Results from recent surveys of margarines, table spreads, and deep frying fats in New Zealand; and
- Results from samples for which the New Zealand Food Composition Database already contained information.

This meant that the focus of the survey was on baked goods, pastry, pies, biscuits, cakes, snackfoods and a few table spreads for which data were not available. The actual samples were:

- Biscuits and cakes (12 samples)
- Table spreads (6 samples)
- Fast food (1 sample – french fries)
- Chocolate (4 samples)
- Snack bars (6 samples)
- Pies and pastry (10 samples)
- Popcorn (2 samples)
- Chips/crisps (2 samples)
- Partially cooked chips/wedges (3 samples)
- Shortening (1 sample)

The *trans* fatty acid content of these samples was generally low (<5% or <5 g *trans* fats per 100 g total fatty acids). Slightly higher values were observed for generic table spreads (6-7%). The absence of samples with higher *trans* fatty acid content in the fat component suggests that partially hydrogenated fats are not widely used by the food manufacturing and bakery industries in New Zealand, and the *trans* fatty acid content of many products comprises the naturally occurring levels in animal fats. Exceptions were imported products (one biscuit and both popcorn samples) whose fat component included approximately 10% and 47% *trans* fatty acids respectively.

Although this survey represents only a small proportion of the many products available, the results for snack bars, table spreads, and butter/plant oil blends suggest that the *trans* fatty acid content of these categories of products has declined since previous surveys in 1995 and 1998.

Lake R, Saunders D, Jones S. (2006) Levels of trans *fatty acids in the New Zealand food supply. ESR Client Report FW0622. Christchurch: ESR.*

4.14 Sulphite, Sorbate and Benzoate Dietary Exposure and Risk Assessment – Children (carried over from 2004-2005)

Preservative compounds are added to foods due to their antibacterial, antifungal, antioxidant activities or their ability to inhibit enzymatic or non-enzymatic reactions in foods. The most widely used food preservative are sulphur dioxide and other sulphiting agents, sorbic acid and its salts, and benzoic acid and its salts.

Thirty foods assessed as being the likely major contributors to dietary preservative exposure were purchased from retail outlets in Auckland, Hamilton, Wellington, Christchurch and Dunedin and prepared as normally consumed.

Mean and 95th percentile estimates of preservative dietary exposure were calculated using food concentration data and food consumption data from the 2002 National Children's Nutrition Survey (2002CNS). Estimates were calculated for respondents (all those for whom food consumption was available) and consumers (respondents who consumed preservative containing foods). Estimated exposures were calculated for four age-gender groups; 5-12-years males and females and 13-15-years males and females.

Mean estimates of dietary exposure were well below the respective Acceptable Daily Intakes for all age-gender groups for all preservatives (17-34, 3-5 and 12-18% of the ADI for sulphite, sorbate and benzoate respectively, for consumers only). Of the 3000 plus daily dietary exposure estimates generated for each preservative, none resulted in a sorbate exposure in excess of the ADI, while only 0.4% of benzoate exposure estimates were above the relevant ADI. Approximately 5% of sulphite exposure estimates exceed the ADI.

Estimates of dietary exposure from the current survey were low compared to most international estimates, and were generally lower than estimates for the Australian population from the recently completed 21st Australian Total Diet Study. Recalculation of New Zealand exposure estimates using Australian concentration data suggest that most of the differences in exposure estimates between New Zealand and Australia are due to differences in the preservative levels in foods, rather than modeling differences.

Sausages are the main food contributing to estimated sulphite dietary exposure for New Zealanders aged 5-15 years, with smaller contributions from soft drinks, hamburger patties, cordial and dried apricots. Estimated sorbate dietary exposure is predominantly due to consumption of orange juice and baked produce (pikelets/crumpets/muffins), with smaller contributions from margarine, chocolate cake and lamingtons. Estimated benzoate dietary exposure is almost solely due to soft drink consumption.

The results of the current survey indicate that dietary exposure to the preservatives, sulphite, sorbate and benzoate, represent a low level of public health risk. It should be noted that the exposure estimates determined in the current survey will be influenced by the assumptions made. The limiting of the number of foods to 30 will result in an underestimate of exposure, although calculations based on Australian survey data suggest that the foods selected will account for more than 98% of preservative exposure. Assumptions such as the mapping of results for refrigerated orange juice to all fruit and vegetable juice will result in a degree of overestimation of exposure. It is uncertain what the cumulative effect of all assumptions will be. The use of 24-hour dietary recall records as an indicator of normal consumption will introduce uncertainties and analysis of exposure estimates based on repeated 24-hour dietary recall records suggest that the probability of an individual exceeding the ADI for a preservative on two different days is extremely low. This suggests that the probability of an individual habitually exceeding the ADI for a preservative is extremely unlikely.

Cressey PJ. (2005) Sulphite, sorbate and benzoate dietary exposure and risk assessment – Children. ESR Client Report FW0594. Christchurch: ESR.

5 CURRENT AWARENESS AND RISK COMMUNICATION

A significant requirement of a public health agency is to respond when necessary to new information and developments. ESR provides NZFSA with a service that monitors local and overseas food safety developments in the areas of chemical safety, microbiological safety, and safety of genetically modified foods. Background information is gathered and reviewed if required. This allows NZFSA to have early and informed information on food safety issues arising elsewhere which may subsequently impact on New Zealand.

To support this information gathering exercise ESR has established a wide network of contacts with overseas experts. This network allows ESR and NZFSA to have access to the most authoritative advice and specialist analytical services related to topical issues.

ESR also assists NZFSA in risk communication activities when needed, typically with preparation or review of documents for the public, or in public presentations.

Projects included in this Science Service in 2005-2006 were:

- Current Awareness: GMFs and Cloning
- Servicing Consumer Information Requests
- Risk Communication

5.1 Current Awareness: GMFs and Cloning

This report is one of a series intended to provide NZFSA with an independent source of current information on issues related to genetically modified foods and foods from cloned animals.

Approvals, Legislative and General Issues

- Plantings of GM crops continue to increase, particularly within the EU, with an annual worldwide growth rate of 11% to the end of 2005.
- The legislative situation on GM foods within the EU continues to be influenced by Member State bans - both those deemed to be illegal, and the continued application for bans.
- Approvals of GM crops by the EU also continue to be hampered by the inability of member states of the EU Agricultural Council to reach agreement on approvals. Proposals are therefore continuing to have to be sent back to the EU Commission for a decision. This results in long time frames for approvals to be made.
- New authorisations by the EU, approved since the 2004 lifting of the moratorium on GMOs, now stand at five. All new approvals are corn crops, engineered for either herbicide tolerance or insect resistance.
- The WTO ruled against the EU in the long awaited decision on the complaint brought by the US and co-complainants that the EU's moratorium on GMOs violated international trade rules. While the decision is unlikely to effect current EU regulations, it is hailed by the US as signalling that countries must abide by international trade laws when dealing with GM as well as non-GM crops.

- Approvals for GM crops being sought both within the EU and within other countries remain largely for lines of Roundup Ready corn and soy and for insect-protected corn.
- Japan continues to test for contamination of seed imports with unapproved GMOs; specifically Bt10 in corn and RT73 in rapeseed.
- Countries continue to adopt regulations governing the import and the labelling of GM products. During this period India has approved new regulations while Hong Kong has agreed to develop a set of voluntary labelling guidelines.
- Results of surveillance surveys to assess compliance with product labelling regulations have been published by the UKFSA (UK Food Standards Agency) and the FSAI (Food Safety Authority of Ireland). In both surveys a proportion of tested products were positive for GM material, however, none contravened the labelling regulations, as the amount of GM material in the products was less than the 0.9% threshold allowed for inadvertent contamination.
- The International Organization for Standardization (ISO) has released Standard 24276:2006, Foodstuffs – Methods of analysis for the detection of genetically modified organisms and derived products – General requirements and definitions.

GM Crop Research

- The literature contains much information related to new GM crops that have been developed or are currently in development. These include lines of rice and potatoes as well as other crops like brassicas, coconut and sugarcane. There is an increasing emphasis on engineering crops to resist biotic and abiotic stress, for example drought stress. Much of this work is being carried out outside of the US, in India and Asia in particular. It is likely that we may see a flood of lesser GM crops entering the human food chain in the next few years as some of these lines are released commercially. The implications of this for food labelling and for compliance testing are significant as i) the number of different crops that may be GM increases, and ii) the range of GM events that these crops contain increases.
- There is also considerable research being reported on ways to improve the generation of transgenic crops. Issues associated with the use of antibiotic resistant marker gene system are being addressed. Plant-derived antibiotic resistance genes have been identified as an alternative, as have marker systems that target plant physiological processes. Work is continuing to develop systems to transfer DNA into plants that rely solely on the use of plant-derived sequences, i.e. intragenic vector systems. These new ways of producing transgenic plants will eventually result in a larger range of types of GM DNA constructs present in the food chain. There are likely to be fewer crops containing the same elements than presently, where for example, most commercial GM crops contain the 35S promoter element. This will have implications for testing of GM crops and will increase the reliance of regulatory bodies on detailed information provided by crop producers on the GM constructs in particular plants.
- International research continues to identify and engineer improved traits into a variety of crop plants. Whilst some of this work is directed at more traits to improve the existing GM crops like canola and corn, there is continued development of secondary crops which target third-world consumers e.g. cassava with greater productivity.
- The focus of much research is on developing methodologies for minimising the flow of transgenes from transgenic crops into the general environment. Two major bodies of work were reported during this period. One describes a system for generating transgenic crops that are fertile but produce non-GM pollen. This system could have

implications for definitions in regulations for labelling of GM foods. The other report developed a strategy to mitigate the effect of ‘escape’ transgenes by generation of GM-non GM hybrids with reduced ecological fitness.

Food from Cloned Animals

There continues to be little development in regulatory issues associated with food from cloned animals. The US FDA (Food and Drug Administration) has yet to release its final policy on safe use of foods from cloned animals. Codex, while recognising the issue, has decided not to address it in the short-term, but is focusing instead on food from transgenic animals. Overall the impression is that foods from transgenic animals possess more of a food safety concern than food from cloned animals. Where it has been assessed, food from cloned animals has been deemed to be as safe as food from conventional animals.

Two summary reports were produced during the 2005-2006 year:

Podivinsky E. (2006) Current awareness of issue related to genetically modified food and food from cloned animals. July - December 2005. ESR Client Report FW0636. Christchurch: ESR.

Podivinsky E. (2006) Current awareness of issue related to genetically modified food and food from cloned animals. January - June 2006. ESR Client Report FW0669. Christchurch: ESR.

5.2 Servicing Consumer Information Requests

Considerable consumer interest was generated by international reports of the occurrence of benzene in soft drinks. It was hypothesised that natural fruits and fruit juices contained all necessary elements for benzene generation and a study was untaken to test the hypothesis that benzene may be naturally formed in these foods.

Studies have demonstrated that benzene, a known carcinogen, can be formed by decarboxylation of benzoic acid in the presence of ascorbic acid. This reaction mechanism appears to be responsible for occurrence of benzene in some benzoate-preserved soft drinks and fruit drinks.

It has been suggested that fresh fruit and products from fresh fruit, specifically fruit juices, and some vegetables contain all the necessary reaction precursors for formation of benzene. While there is significant data on the amount of ascorbic acid in a range of fresh produce, there is little information on the benzoic acid content of these products.

Analysis of 33 fresh fruit and vegetable samples and 21 non-benzoate-preserved fruit juices did not detect benzene in any sample above the method detection limit of 1 µg/kg. These results are consistent with other published results that concluded that when benzene is present it is present at levels less than 1 µg/kg. The very low levels of benzene could be present due to *in situ* formation or due to absorption of benzene from the environment.

It is uncertain why benzene is not formed in fruit or vegetables. We suggest that it may be due to a non-optimal ratio of benzoic acid to ascorbic acid in these foods.

Cressey P, Grounds P. (2006) Benzene in fruit and fruit products. ESR Client Report FW0650. Christchurch: ESR.

5.3 Risk Communication

The Risk Communication work area has been developed to allow ESR scientists with expertise in food safety to work with NZFSA to communicate food safety information to the consumer as part of a process of increasing consumer awareness and allowing consumers to better understand food risks.

This work has involved both the production of written material and presentation of verbal communications to consumers or consumer groups to clarify food safety issues.

Topics for which written material was provided included:

- Synthetic colours in highly coloured foods eaten by children
- Preservatives in New Zealand's food supply
- Domestic food handling practices
- Changing food safety behaviour of the consumer
- Bisphenol A in canned foods and exposure assessment
- Nitrates and nitrites dietary exposure and risk assessment
- Fact Sheet - Preventing cross contamination when handling raw poultry
- Fact Sheet - Safe cooking of meat (liver vs sausages & mince vs steak)
- Fact Sheet - What to do when your freezer breaks down - food safety issues and how to avoid them
- Fact Sheet - Food safety issues with raw milk
- Fact sheet - MSG - Food safety information
- Fact sheet - Food safety issues associated with sushi

A range of media activities associated with specific projects were also carried out under this project, including press releases, interviews with radio and newspaper journalists to promote the Foodsafe Partnership and Food Safety week, and television interviews.

6 EMERGENCY RESPONSE

This service description ensures that ESR capability across the spectrum of food safety science is available to deal with emergency responses to food safety incidents. In order to maintain capability, supplementary research projects, agreed with NZFSA, are undertaken when not engaged in emergency response investigations.

During the 2005-2006 year there was little call for work to respond to emergencies and the funds in this project were used to initiate new projects or to allow additional work to be carried out under existing projects. This included additional work under:

- Risk profiling;
- Further development of a risk model for *Salmonella* in poultry in New Zealand;
- Fortification overages of the food supply;
- Levels of *trans* fatty acids in the New Zealand food supply; and
- Risk communication.

In addition, funds from the Emergency Response Service Description were used to provide:

- Input into investigation of potential contamination of honey by the toxin tutin;
- Additional analysis of cadmium data from the 2003-2004 New Zealand Total Diet Survey; and
- Analysis of the iodine content of processed foods, to complement work carried out under the 2003-2004 New Zealand Total Diet Survey; and
- Investigation of strain types amongst New Zealand *E. coli* O157:H7 isolates (continuing in 2006-2007).

The work on iodine has been reported in:

Love J, Jones S. (2006) Iodine in New Zealand foods. ESR Client Report FW0631. Christchurch: ESR.

7 NZFSA/HPO TECHNICAL SUPPORT

ESR has for many years provided the NZFSA, the Ministry of Health, and District Health Boards with analytical results, scientific advice and consultation relating to the chemical and microbiological quality of food. It is important that regulatory staff have the best quality analytical results and that they have access to current scientific background information if they are to take the most appropriate actions. It is also important that requests for analytical work and advice are scientifically assessed in terms of the identified issue and that requested work is focused on supporting a regulatory solution to this issue. It is also important that ESR has appropriate support structures and access to other relevant information on food safety in New Zealand if it is to be able to provide scientific advice relevant to New Zealand.

The Science Service covers the following areas of science support:

- Data Transmission
- Food Complaints
- Food Consultation/Courier
- Annual report

7.1 Data Transmission

Each day, ESR transfers an electronic version of completed results generated by ESR's Food Chemistry and Public Health Laboratories into the NZFSA FoodNet database. The NZFSA then replicates selected results into versions of FoodNet held by District Health Boards and the Ministry of Health.

Transmitted data includes results from the testing of foods within the NZFSA Science Contract, results from the testing of samples related to suspected food poisoning incidents and clinical samples within the Ministry of Health contract, and the testing of imported foods submitted to ESR as part of the requirements for the importation of high risk foods.

It is important that transmitted results are reliable and the project involves a quality assurance component to ensure results within the FoodNet system accurately reflect the original data held by ESR and involves checking a selection of data held in FoodNet against the original version. Quality assurance also involves ensuring that ESR staff approve completed results so that they are transmitted to FoodNet in a timely manner and that identified missing information is followed up to ensure analytical results can be cross referenced to other information on the same events and samples held in other food and health related databases.

7.2 Food Complaints

When consumers feel that the food they have purchased is unacceptable in some way these foods may be submitted to Health Protection staff at District Health Boards for investigation. This investigation will, in some instances, include laboratory analysis by ESR. The most common reasons consumers complain about foods are:

- The presence of an unexpected and unwanted item in the food (Foreign objects)
- The presence of an unexpected and unwanted taste or odour in the food (Taint)
- The belief that the food has ‘gone off’ (Spoilage). This belief may be based on the taste, odour or appearance of the food

- The belief that the food may contain a contaminant, such as pesticide residues or pathogenic bacteria (Contamination)
- The belief that a food contains additives which it shouldn't (Adulteration)

During the 2005-2006 year 167 food complaints were submitted to ESR laboratories for investigation, an increase from the number submitted during 2004-2005 (148). The largest proportion of these was from the Auckland area (23%), followed by Canterbury (21%). The patterns of foods associated with complaints and the types of complaints made are consistent with previous years. In 2005-2006 the types of foods most commonly associated with food complaints were takeaway foods, bread and bakery products, meat and poultry products, and seafood.

As in other years, the most common reason for making a food complaint was the presence of a foreign object in a food item. During 2005-2006, 59% of all food complaints were related to foreign objects. This is similar to the pattern for 2004-2005 when 63% of all food complaints submitted to ESR related to foreign objects. The types of foreign objects most commonly identified were insects (including eggs, pupae and caterpillars), glass, plastic fragments, metallic fragments or items, fibres and rodent droppings. About 30% of foreign object complaints were unsubstantiated with many foreign objects submitted as food complaints appearing to be normal components of food.

The majority of samples submitted for microbiological examination this year have been related incidents where the food was believed to be spoiled. Complaints relating to the presence of allergens (incorrect labeling/composition) continue to increase.

Wilson MW, Whyte RJ. (2006) Food complaints and foodborne illness: six-month summary report July to December 2005. ESR Client Report FW0613. Auckland: ESR

Wilson MW, Graham CF. (2006) Food complaints and foodborne illness: six-month summary report January to June 2006. ESR Client Report FW0668. Auckland: ESR

7.3 Food Consultation/Courier

The Food Consultation work area provides a mechanism by which staff of Public Health Units and NZFSA can seek advice from ESR consultants with scientific skills and expertise in the area of food safety. These enquiries may be answered by an email or telephone response or may receive more extensive written replies.

The majority of requests continue to be for scientific support in the area of Food Safety Programme evaluation, which involves HPOs reviewing food production processes and determining whether all potential hazards have been identified, and appropriate controls implemented to prevent hazards from occurring. Enquiries ranged from smoked fish and dried vegetable production through to more specialised foods such as hummus, sprouted seeds and biltong.

No analytical projects were carried out within this work programme during 2005-2006.

Two training workshops for HPOs were held during the year, one in Auckland and one in Christchurch. Workshops included technical presentations and presentations on key food safety projects. Technical presentations included:

- Using hurdle technology to ensure food safety (Dr Andrew Hudson);
- Hurdles to control *Clostridium botulinum* (Sue Gilbert);
- Time/temperature combinations for controlling pathogens (Dr Glenn Bayne);
- Allergen detection and management (Peter Cressey);
- Risks associated with food additives and other chemicals that may be in foods (Dr John Love); and
- Chemical risks associated with packaging (Dr Jim Mitchell).

Project presentations included:

- Bugs in Spuds – Survey of *Bacillus cereus* in hot-held ready-to-eat potato products (Nicola King)
- Survey of retail meat temperatures in supermarkets and butcheries (Rosemary Whyte)
- Survey of pet chews for *Salmonella* (Dr TeckLok Wong)
- Survey of egg surfaces and contents for *Salmonella* (Maurice Wilson)
- NZTDS issues identified (Dr Richard Vannoort)
- Toxic dyes – results of spices and condiments survey (Darren Saunders)
- Survey of folate and iron in fortified foods for compliance with label claims (Peter Cressey)
- Too much salt – analysis of salt intake from processed foods (Dr Richard Vannoort)

Consultation provided as part of this service was summarised in four quarterly reports:

Whyte R. (2005) Food consultation. Quarterly progress report July to September 2005. ESR Client Report FW05114. Christchurch: ESR.

Whyte R. (2006) Food consultation. Quarterly progress report October to December 2005. ESR Client Report FW0606. Christchurch: ESR.

Whyte R. (2006) Food consultation. Quarterly progress report January to March 2006. ESR Client Report FW0627. Christchurch: ESR.

Gilbert S. (2006) Food consultation. Quarterly progress report April to June 2006. ESR Client Report FW0643. Christchurch: ESR.

APPENDIX 1 NEW ZEALAND FOOD SAFETY AUTHORITY – ESR SCIENCE CONTRACT 2005-2006. SERVICE DESCRIPTIONS, WORK AREAS AND AGREED OUTPUTS

MICROBIOLOGICAL RISK PROFILING

Risk Profiling

- *Risk profile of C.botulinum in ready-to-eat smoked seafood in sealed packaging.*
- *Risk profile of C.botulinum in honey*
- *Updated risk profile of STEC in uncooked comminuted fermented meats.*

Food Consumption Data for Risk Assessments

- *Delivery of final peer-reviewed report*

MICROBIOLOGICAL FOOD SAFETY

Implementation and optimisation of the National Typing Database: PFGE typing of residual isolates

- *Report to NZFSA on PFGE similarity between survey and human sub-types (deferred to 2006-2007)*

Prevalence and numbers of *Campylobacter* and *Salmonella* on chickens prior to scalding

- *Provide report to NZFSA in journal paper format*

Quantitative risk assessment: *Campylobacter* in red meat and poultry from retail to human consumption

- *Final report as draft scientific paper plus data appendices and model submitted to NZFSA*

Further development of a risk model for *Campylobacter* in poultry in New Zealand

- *Project report and draft scientific paper supplied to NZFSA*
- *Further develop, peer-reviewed model supplied to NZFSA*

Survey of *Salmonella* contamination of retail eggs

- *Draft scientific paper to NZFSA*

Further development of a risk model for *Salmonella* in poultry in New Zealand

- *Finalised model and report supplied to NZFSA.*

Microbiology of uncooked retail meat products: *Salmonella* and STEC

- *Final report as draft scientific paper plus data appendices submitted to NZFSA*

Shiga toxin production by STECs isolated from the Microbiology of uncooked retail meat products project

- *Final report in draft scientific paper format submitted to NZFSA*

Microbiological survey of imported and domestic pet chews: *Salmonella*

- *Draft scientific paper for submission to Journal of Food Protection to NZFSA*

Domestic Food Practices

- *Provision of final second year report/scientific paper(s) to NZFSA*

Yersinia in meat: Analytical Development and Survey

- *Complete half sampling programme (300 samples maximum)*

Exposure Assessment to *Listeria monocytogenes* via Unpackaged Ready-to-eat meats

- *Report in journal paper format to NZFSA*

Exposure Assessment to *Listeria monocytogenes* via Deli Ready-to-eat salads (with dressings)

- *Brief email updates when necessary with brief summary provided in quarterly report*

Analytical development – Norovirus Detection

- *Submit final externally peer reviewed validation report and any ESR response to peer review to NZFSA*
- *Process and Quality manuals for accreditation including complete documentation for method completed*
- *Initial IANZ Audit completed*
- *Submission of draft scientific paper to NZFSA along with appendices of data and analysis*

Inactivation of Norovirus by low temperatures

- *Prepare draft scientific paper for international peer review and submit to NZFSA along with appendices of data and analysis*

Modular contribution to NZFSA pasteurisation risk model

- *Final report provided to NZFSA*

Resuscitation of putative viable but non culturable foodborne bacteria of significance to New Zealand

- *Agree timeline and overall project direction with NZFSA and University partner. Confirm availability of Masters Candidate*

Validation of visual inspection of foods in relation to critical limits

- *Report to NZFSA in the form of a draft Review or Scientific paper for submission to an international peer-reviewed journal (e.g. JFP)*

CHEMICAL FOOD SAFETY

2003-04 New Zealand Total Diet Study (NZTDS)

- *Finalisation of reports*
- *Preparation of material for release to media and key stakeholders*
- *Presentation of material at NZFSA conference*
- *Review of 2003/04 NZTDS*

Food residues surveillance programme

- *Final 2004-2005 report to NZFSA*
- *Chapter written for draft annual report*

WHO GEMS/Food

- *Audit New Zealand data held by WHO GEMS/Food for completeness and accuracy*
- *Extract, format and submit to WHO relevant New Zealand food contaminant and residue data for 2005 calendar year*
- *Complete annual report and proposed work plans for submission to WHO*

Genetically Modified Food Analysis and Capability Development

- *Six monthly progress report on results of sample analyses submitted to NZFSA*
- *Final written overview of the years work*
- *Final written overview provided of research results, with particular reference to capability maintenance/development for detection of GM components in food by TaqMan methodology*

Fortification overages of the food supply

- *Final report to NZFSA*

Allergenicity capability development and consulting

- *Summary activities for inclusion in Annual Report of NZFSA-ESR contract*

Bulk food shipping contamination

- *Final report to NZFSA (discontinued during 2005-2006)*

Monitoring of Sudan dye

- Final report, in spread sheet format, outlining samples taken and results found and a paper outlining any trends identified i.e. country of origin or spice type

Chemical risk profile for mycotoxins in New Zealand foods

- *Final scoping document to NZFSA*

Scoping Malachite green

- *Final report to NZFSA*

Risk profile for imported ceramic and enamel human food containers

- *Final report to NZFSA*

Survey of salt in processed foods

- *Final report to NZFSA*

Levels of trans fatty acids in the New Zealand food supply

- *Final report to NZFSA*

CURRENT AWARENESS AND EMERGING ISSUES

Current Awareness: GMFs and cloning

- *Two six-monthly summary reports*

Servicing consumer information requests

- *Copies of all short reports produced*
- *Summary of reports produced, as a component of the quarterly reporting*

Risk Communication

- *Copies of all short reports produced (12)*
- *Risk communications material and summary of public health issues stemming from projects carried out and completed during the 04/05 contract period to be submitted*

EMERGENCY RESPONSE

Emergency response and emerging issues

- *Report of the work within the Service Description presented at quarterly meetings*

NZFSA/HPO TECHNICAL SUPPORT

Data transmission

- *Daily delivery of accurate data from ESR to FoodNet*

Food complaints

- *Quarterly budget reports to NZFSA*
- *Six monthly reports summarising sample numbers, food types, laboratory results and, where available, other information relating to CCP failures and follow up action*

Food consultation/courier

- *Quarterly reports on advice given and other activity to the NZFSA.*
- *Quarterly utilisation summary*
- *One training workshop for HPOs at both the Christchurch and Auckland sites of ESR*
- *Evaluation report on HPO training workshops*

Annual report

- *Submission of final report*