Australian Government
Australian Quarantine and Inspection Service

AQIS Imported Food Surveys

Survey of Chemicals in Imported Seafood

Prepared by the Imported Food Program
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Executive Summary

The Australian Quarantine and Inspection Service (AQIS) tested 100 samples of seafood for residues of 88 agricultural and veterinary compounds. These samples were volunteered by importers and collected by AQIS between April 2006 and March 2007.

Residues of one or more antimicrobial chemicals were detected in 31 of the seafood samples tested. The levels were all low and posed no significant safety concerns.

The Australian government has committed to a review of the existing testing protocols for seafood imports and to further consider any measures necessary to improve the food safety standards of imported seafood products as part of the government's plan for sustainable fisheries.

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Background

AQIS undertakes testing of imported seafood at the rate of 5% of consignments to monitor compliance with the Australia New Zealand Food Standards Code (Food Standards Code). This testing program is in addition to testing for food classified as "risk" by Food Standards Australia New Zealand (FSANZ). The rates of inspection of risk food and for compliance monitoring are prescribed by the *Imported Food Control Act 1992*.

Testing of imported prawns for nitrofurans and chloramphenicol has been conducted since 2003. In 2005 AQIS introduced testing for malachite green as part of the routine sampling of imported aquaculture fish. In the 2006 calendar year, imported seafood tested for these antimicrobial compounds showed above 95% compliance with the Food Standards Code.

The testing of imported seafood for the above chemicals has been introduced following information from domestic findings, including a number of Australian surveys that detected antimicrobial chemicals, such as:

- A 2005 FSANZ led national survey of chemical residues in aquaculture fish co-ordinated by FSANZ which tested for a range of veterinary residues such as nitrofurans, chloramphenicol, sulphonamides, tetracyclines, penicillins, macrolides, and quinolones, and also for polychlorinated biphenyls and a number of heavy metals. This survey found that residues of these veterinary chemicals in aquaculture fish were generally compliant with the Food Standards Code except for residues of malachite green and/or its metabolite leuco-malachite green in some domestically produced finfish and imported seafood.
- A 2005 survey undertaken by South Australia which detected low levels of chloramphenicol in some imported crab meat.

In 2006 there were concerns that other chemicals may be present in seafood, particularly in farmed seafood and testing would need to be broadened to cover other chemicals. Of particular concern was the possible occurrence of veterinary compounds that are of critical importance in human medicine.

To investigate whether new chemicals needed to be added to the testing program, AQIS conducted a snapshot survey of antimicrobial and pesticide chemicals in imported seafood.

Method

A total of 100 samples were collected by AQIS officers. These samples were volunteered by the importer of the seafood and were collected aseptically by AQIS officers from the consignment being imported, using the sampling protocol given in Attachment 1. The samples were taken from imports at four points of entry into Australia (Sydney, Perth, Melbourne and Brisbane). The samples collected were of fish (excluding shark), crustacea (prawns and crab only) and eels. The seafood was chilled or frozen, cooked or uncooked and included both wild caught and farmed product. Canned, dried, battered or mixed seafood products were excluded from this survey.

There was no screening or targeting of these samples for specific country of origin or seafood species. The samples were primarily taken from consignments randomly referred to AQIS under the 5% random surveillance category.

An analyst appointed under the *Imported Food Control Act 1992*, Advanced Analytical Australia Pty Ltd, conducted the analysis of all samples. The testing was carried out using Liquid Chromatography Tandem Mass Spectrometry (LCMSMS) and extended Gas Chromatography Tandem Mass Spectrometry (GCMSMS). Each sample was tested against 88 agricultural and veterinary compounds which are listed in Tables 3 and 5.

AQIS acknowledges the support and co-operation of importers of seafood products that participated in this survey.

Results from the survey

Summary

- No residues of the 49 agricultural pesticides were detected in the seafood samples.
- Residues of one or more veterinary compounds were detected at quantifiable levels in 31 of the 100 seafood samples.
- Residues of 13 veterinary compounds were detected in the 31 positive seafood samples. The residues detected belong to the sulphonamide, tetracycline, malachite green, penicillin, quinolone, fluoroquinolone and phenicol antimicrobial chemical groups.
- The seafood products found to contain residues of veterinary compounds were from China, Indonesia, New Zealand, Thailand and Vietnam.
- Of the 31 samples with detected residues, 9 were declared as farmed seafood, 14 samples were declared as wild caught and 8 did not declare the type of production.

Detailed results

The 100 samples were taken from seafood commodities as shown in Table 1 which also shows the detections by seafood commodity.

Table 1: Number of samples and detections by seafood commodity

Seafood commodity	No. of samples	No. of detections
Fish	53	16
Prawns	36	12
Crabs	9	2
Eels	2	1
	100	**31**

Table 2 shows the number of samples and detections of residues from each of the 15 countries of origin.

Table 2: Number of samples and detections by country

Country	No. of samples	No. of detections
Argentina	1	0
Canada	1	0
China	16	10
Denmark	1	0
Indonesia	30	10
Malaysia	2	0
Myanmar	3	0
New Zealand	13	6
Norway	1	0
Papua New Guinea	1	0
Saudi Arabia	2	0
South Africa	2	0
South Korea	2	0
Thailand	12	2
Vietnam	13	3

Table 3 shows the testing results against the 49 agricultural (pesticide) chemicals.

Table 3: Results against agricultural compounds

Chemical	No. of detections
Acephate	0
Aldrin	0
Azinphos-ethyl	0
Azinphos-methyl	0
BHC (alpha, beta, delta, gamma)	0
Bromophos-ethyl	0
Carbaryl	0
Carbophenothion	0
Chlordane	0
Chlorpyrifos	0
Chlorpyrifos-methyl	0
Chlorfenvinphos (cis & tran)	0
DDD	0
DDE	0
DDT	0
Demeton-S-methyl	0
Diazinon	0
Dichlorvos	0
Dicofol	0
Dieldrin	0
Dimethoate	0
Disulfoton	0
Endosulfan (alpha & beta)	0
Endosulfan sulphate	0
Ethoprofos	0

Chemical	No. of detections
Ethion	0
Fenamiphos	0
Fenitrothion	0
Fenthion	0
Fipronil	0
Hexachlorobenzene	0
Heptachlor	0
Heptachlor epoxide	0
Malathion	0
Methacrifos	0
Methamidophos	0
Methidathion	0
Mevinphos	0
Monocrotophos	0
Omethoate	0
Parathion	0
Parathion-methyl	0
Phorate	0
Phosmet	0
Pirimicarb	0
Pirimiphos-methyl	0
Procymidone	0
Prothiofos	0
Vamidathion	0

Table 4 shows detections in each of the four seafood commodities of residues against broad veterinary compound group.

Table 4: Number of detections against veterinary compound class/seafood commodity

	Sulphonamides	Tetracyclines	Malachite green	Penicillin	Quinolones	Fluoro-quinolones	Phenicols
Fish	-	2	1	11	2	-	-
Crabs	-	1	-	1	-	-	-
Eels	1	-	-	-	-	-	-
Prawns	4	4	-	-	4	1	1
Total	5	7	1	12	6	1	1

NOTE: some seafood samples contained more than one compound thus the total number of residues detected exceeds the number of samples with detections.

Table 5 identifies detections of specific chemicals. Shaded cells identify the individual antimicrobial compounds detected.

Table 5: Number of detections of veterinary compounds (antimicrobial chemical)

Group	Chemical	No. of tests	No. of detections	Chemical	No. of tests	No. of detections
Malachite green	Malachite green	100	1	Leucomalachite green	100	0
Quinolones	Flumequine	100	6	Oxolinic Acid	100	0
Phenicols	Florfenicol	100	1	Thiamphenicol	100	0
Macrolides	Tylosin	100	0	Erythromycin	100	0
Fluoro-quinolones	Ciprofloxacin	100	1	Ofloxacin	100	0
	Enrofloxacin	100	2	Gatifloxacin	100	0
	Levofloxacin	100	0	Moxifloxacin	100	0
	Sarafloxacin	100	0	Norfloxacin	100	0
Tetracyclines	Chlortetracycline	100	0	Tetracycline	100	0
	Doxycycline	100	0	Oxytetracycline	100	7
Sulphonamides	Sulphamerazine	100	0	Sulphamethoxazole	100	5
	Sulphadimethoxine	100	1	Sulphamethoxypyridazine	100	1
	Sulphachlorpyridazine	100	0	Sulphapyridine	100	0
	Sulphadiazine	100	0	Sulphaquinoxaline	100	0
	Sulphadoxine	100	0	Sulphathiazole	100	0
	Sulphamethazine	100	1	Sulphatroxazole	100	0
	Sulphameter	100	1	Sulphisoxazole	100	0
Penicillin	Ampicillin	100	3	Benzyl penicillin	100	0
	Amoxycillin	100	11	Cloxacillin	100	0
Other	Trimethoprim	100	0			

NOTE: some seafood samples contained more than one compound thus the total number of residues detected exceeds the number of samples with detections.

Table 6 shows the breakdown of detections against commodity and country. Shaded cells identify commodities where residues were detected.

Table 6: Number of samples and detections by country

Country	Commodity	No. of samples	No. of detections
Argentina	Fish	1	0
Canada	Prawns	1	0
China	Fish	1	0
	Prawns	14	9
	Eel	1	1
Denmark	Prawns	1	0
Indonesia	Fish	25	7
	Prawns	1	1
	Crab	4	2
Malaysia	Prawns	2	0
Myanmar	Prawns	3	0
New Zealand	Fish	12	6
	Eel	1	0
Norway	Fish	1	0
Papua New Guinea	Prawns	1	0
Saudi Arabia	Prawns	2	0
South Africa	Fish	2	0
South Korea	Fish	2	0
Thailand	Fish	2	0
	Prawns	9	2
	Crab	1	0
Vietnam	Fish	7	2
	Prawns	3	1
	Crab	3	0
Total		100	31

Tables 7 and 8 detail the levels of residues detected against commodity and country.

Table 7: Levels of antimicrobial residues detected by seafood commodity and country (Note: 1µg/kg = 0.000001 grams/kg = 1 part per billion)

Country	Product	Sulphonamide	Tetracyclines	Malachite green	Penicillin		Quinolones / Fluoroquinolones			Phenicols
		Sulpha-methoxazole µg/kg	Oxytetracycline µg/kg	µg/kg	Amoxycillin µg/kg	Ampicillin µg/kg	Flumequine µg/kg	Ciprofloxacin µg/kg	Enrofloxacin µg/kg	Florfenicol µg/kg
China[1]	Fish	-	-	-	-	-	-	-	-	-
	Prawns	2.3-5.4	8.6	-	-	-	2.6-17	3.1	33-130	11
Indonesia	Fish	-	2.0	-	14-130	-	2.0	-	-	-
	Prawns	-	3.4	-	-	-	-	-	-	-
	Crab	-	6.7	-	380	-		-	-	-
New Zealand	Fish	-	-	-	25-71	10-130	-	-	-	-
Thailand	Prawns	-	2.1	-	-	-	3.4	-	-	-
Vietnam	Fish	-	5.9	7.8	-	-	8.2	-	-	-
	Prawns	-	2.0	-	-	-	-	-	-	-

[1] one eel sample was detected with a range of residues from several chemicals from the sulphonamide antimicrobial group. The results for this sample are detailed in Table 8

Table 8: Levels of sulphonamide residues detected in one eel sample from China

	Sulphadimethoxine µg/kg	Sulphamethazine (Sulfadimidine) µg/kg	Sulphameter µg/kg	Sulphamethoxazole µg/kg	Sulphamethoxypyridazine µg/kg
Eel - China	3.4	8.6	12	-	12

The results of the survey were reviewed by FSANZ and the National Health and Medical Research Council (NHMRC) to provide advice on the public health and safety risks associated with the detected residues. The NHMRC sought advice on antimicrobial resistance from its Expert Advisory Group on Antimicrobial Resistance (EAGAR).

FSANZ safety assessment

Based on dietary modelling, the FSANZ assessment did not identify any major safety concerns associated with the low levels of antimicrobial residues detected. On these grounds, the residues do not constitute a medium to high risk to public health and safety. The full FSANZ report is available as a separate document on the AQIS website.

The dietary exposure assessment involved comparing estimated dietary exposures with the established reference health standard for each chemical. Based on this assessment for each chemical and a worst case scenario, the quantities of a particular seafood that would need to be consumed before reaching levels near the reference health standard are generally very large. In the majority of cases, the limit is not reached unless hundreds and sometimes thousands of kilograms of a particular seafood are consumed each day over a lifetime. The estimates of seafood consumption required to exceed the Acceptable Daily Intake (ADI) for a range of chemicals are listed in Table 9.

EAGAR assessment of antimicrobial resistance

EAGAR noted that the presence of antimicrobial compounds was of concern for all sources of farmed seafood, including domestically produced product. EAGAR expressed concerns particularly about the presence of fluoroquinolone (flumequine, ciprofloxacin and enrofloxacin) residues, which were found predominantly in prawns. EAGAR considers that any development of resistance to fluoroquinolones would constitute a high risk to their efficacy in clinical medicine.

Table 9: Seafood consumption required to exceed the ADI for the chemicals detected

Chemical	Commodity	Maximum detected concentration (µg/kg)	ADI (mg/kg bw)	Approximate consumption amounts required to exceed ADI (kg/day)
Sulphamethazine	Eel	8.6	0.02	155
Sulphadimethoxine	Eel	3.4	0.20	3,941
Sulphamethoxy-pyridazine	Eel	12	0.20	1,116
Sulphameter	Eel	12	0.10	558
Sulphamethoxazole	Fish (NFS)	5.0	0.20	2,680
	Prawns	5.4	0.20	2,481
Oxytetracycline	Crab	6.7	0.03	300
	Garfish	2.0	0.03	1,005
	Prawn	8.6	0.03	233
	Climbing Perch	5.9	0.03	340
Amoxicyllin	Barramundi	35	0.20	382
	Crab	380	0.20	35
	Fish (NFS)	58	0.2	231
	Hairtail	130	0.20	103
	Ling	71	0.20	188
	Swordfish	51	0.20	262
Ampicillin	Orange Roughy	10	0.20	1,340
	Ling	16	0.20	837
	Swordfish	130	0.20	103
Flumequine	Mackerel	2.0	0.03	1,005
	Prawns	17	0.03	118
	Spanish Mackerel	8.2	0.03	245
Ciprofloxacin	Prawn	3.1	0.002	43
Enrofloxacin	Fish (NFS)	33	0.002	4
	Prawns	130	0.002	1
Florfenicol	Prawns	11	0.001	6

Notes: No other background exposure from other foods considered.
(NFS) = not further specified
Mean body weight of 67kg used for Australians aged 2 years and above.

This table is an extract from the formal advice provided to AQIS by FSANZ. The Acceptable Daily Intake (ADI) levels as used in the above table are explained in that formal advice.

Discussion of the survey results

Imported seafood has been found to contain residues of some veterinary compounds that do not currently have a Maximum Residue Limit (MRL – see Appendix A) in the Food Standards Code. As such, this seafood is not compliant with Australian food standards.

There is no significant safety concern with the detected residues as the levels are low. In the majority of cases, the quantities of seafood that would need to be consumed before reaching levels of exposure near the acceptable daily intake are in the hundreds of kilograms.

EAGAR has concern about the presence of residues of antimicrobial compounds of significance in human medicine, in particular the fluoroquinolone compounds.

The Australian government has committed to a review of the existing testing protocols for seafood imports and to further consider any measures necessary to improve the food safety standards of imported seafood products as part of the government's plan for sustainable fisheries. This review will be completed by the end of 2008.

Appendix A

MRLs for veterinary compounds

An MRL is the highest concentration of a residue of a particular chemical that is legally permitted or accepted in a food or animal feed. The concentration is expressed in milligrams of the chemical residue per kilogram (mg/kg) of the commodity. MRLs are regulatory standards which help to monitor that the chemical product has been used as directed on the approved label. If an MRL is exceeded, it usually indicates a misuse of the chemical but does not normally indicate a public health or safety concern.

The Food Standards Code includes the permitted MRLs for agricultural and veterinary chemicals in food for sale in Australia. As some antimicrobials are not permitted for agricultural use in Australia, no detectable residues are permitted under the Food Standards Code.

Therefore, the detections of such chemical residues in this survey for various seafoods indicates that those seafoods are non-compliant with the Food Standards Code.

As identified in Table 10, the levels of residues detected in some of the imported seafood samples would not constitute compliance breaches in the country of production or in other export destinations; that is, residues in seafood at these levels has been assessed as safe by regulators in those countries. The Codex Alimentarius Commission has also established MRLs for some of these veterinary compounds in food producing animals, including one for oxytetracycline in prawn muscle. In most cases, MRLs have been established in edible tissues of food producing animals at levels that are much higher than observed in the current survey of seafood.

Table 10: Comparison of detected residue levels with Maximum Residue Limits (MRLs) for other countries

	Sulphonamide					**Tetra-cycline**	**Malachite green**	**Penicillin**		**Quinolones / Fluoro-quinolones**			**Phenicols**
	Sulphadi-methoxine µg/kg	**Sulphamethazine (Sulfadimidine)** µg/kg	**Sulpha-meter** µg/kg	**Sulpha-methoxazole** µg/kg	**Sulphameth-oxypyridazine** µg/kg	**Oxy-tetracycline** µg/kg	µg/kg	**Amoxycillin** µg/kg	**Ampicillin** µg/kg	**Flumequine** µg/kg	**Cipro-floxacin** µg/kg	**Enro-floxacin** µg/kg	**Flor-fenicol** µg/kg
AQIS Survey detections	3.4	8.6	12	2.3-5.4	12	2.0-8.6	7.8	14-380	10-130	2.0-17	3.1	33-130	11
EU MRL	100	100	100	100	100	100		50	50	600 (fin fish) 200 (all other food producing species)	100	100	1000 (fin fish only) 100 (all other food producing species)
US MRL						2000							2000 (catfish only)
Codex MRL						200				500 (trout)			
No. samples failed Australian MRL	1	1	1	5	1	7	1	11	3	6	1	2	1
No. samples that exceeded the highest of NZ*, EU, US or Codex MRLs	0	0	0	0	0	0	1	3	1	0	0	1	0

* New Zealand has a default MRL of 100 ug/kg where the specific food/residue combination has not been assessed. However, the default MRL does not override the prohibition in the Food Act on the sale of food that is unfit for human.

Attachment 1

Sampling Protocol

All sampling for the survey is to occur when the Imported Food inspection is undertaken.

Please conduct normal inspection activities, including sampling. At the end of the inspection activities, please take an additional sample.

General notes

- Sample quantity: 500 grams
- Sample portion: the edible portion
- Sample preparation: samples are to be tested "as is" – that is, fish fillets or marinade fish etc must not be washed or rinsed or otherwise treated prior to testing.

Drawing the samples

1) Obtain permission to draw a sample
2) Ensure that conditions are suitable for sampling – aseptic sampling is required
3) Collect sample and place into the appropriate container
4) Seal sample container
5) Clean equipment
6) Continue until all sub-samples have been sampled
7) Place all sub-samples into an IFP tamper evident bag, and attach a completed 'Sample Identification Form' to the bag
8) Deliver sample to laboratory sample depot for laboratory pick up
9) Keep all samples frozen including where the product had only been chilled
10) Notify laboratory to arrange for collection of sample