PART 2: ATTACHMENTS

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Attachment 1

Egg Production Profile

Assumptions
The following assumptions were used in order to come to these conclusions.

These are:

1. All Layer Eggs 100% equal to 230 million dozen per year (Horn, 2004) (even this is a moving target with opinion indicating it may be an underestimate by 15% - 20%).
2. 10% Non-commercial i.e.: coming from backyard flocks or small commercial farmers selling direct.
3. That as a rule of thumb 10% of all eggs are second quality i.e.: broken, misshapen, cracked etc. (of the 10%, 8% are probably cracked and 2% are misshapen etc.).
4. For commercial eggs that are Free Range (FR) or Barn Laid (BL) it is assumed that half are graded out at processing floors and are sent to processing (breaking into liquid product) and the other half fit into 2. as FR/BL's tend to be small commercial farmers.
5. In the non-commercial area the "worst" is assumed that all second quality eggs are sold/supplied into the market "illegally" i.e. non-compliant with the Egg and Egg Products Standard 2.2.2. From point 3 above, it is assumed that 10% of non-commercial eggs fall into the seconds/cracked category, and as these sources don't have access to pulping/pasteurising systems are lost into the market – estimated to be 1% of non-commercial eggs produced (Figure 1.1).
6. Processing eggs – these eggs are first quality eggs usually from commercial operations that are fed directly to processing to fill the demand. These eggs are either grown specifically for this purpose or are taken at times of surplus or to balance grades but generally they are good eggs.
7. An anecdotal estimate of fertile eggs has been added. This is a relatively small component.
8. Non-commercial – 5% cage laid definition: It is assumed that 50% of the 10% non-commercial (Figure 1.1) are in old cage systems in flocks up to 1000 layers, selling direct into the market. These are not considered as part of the core industry, and often exist as small operations on mixed farms, where they are a minor part of the overall farm operations and income. Non-commercial also implies eggs are ungraded. Being ungraded they are likely to include a proportion of cracked eggs which are illegal to sell.
9. Based on current weekly broiler numbers, livability, hatchability and recovery rates there is the potential for 344,000 and above fertile breeder eggs per week to be available for human consumption. (1.49 million dozen/year) (pers. comm. Peter Scott).
10. Unpasteurised pulp. From anecdotal information it is estimated that up to 500kg/wk of unpasteurised pulp derived from seconds/cracked eggs is sold for manufacturing purposes. This is considered legal under Standard 2.2.2 (Clauses 2. 2 and 3. 1).

As a back check on the numbers the following calculation was conducted:

Approx: 15,000 tonnes of pulp per year
13% of 230 million dozen = 29,900,000doz eggs per year
Approx: 2 doz per kilo = 14,950 tonnes.... a close check.
(Sources: P. Steele, P. Scott, R. Horn, AECL-G. Runge)

Horn R. (2004) Australian Egg Industry Annual Statistical Publication 2003. Australian Egg Corporation Ltd. Publication No. 04/01. Project No. ROW-1A

Figure 1.1. Egg Production Profile (Breakdown by Percentage)

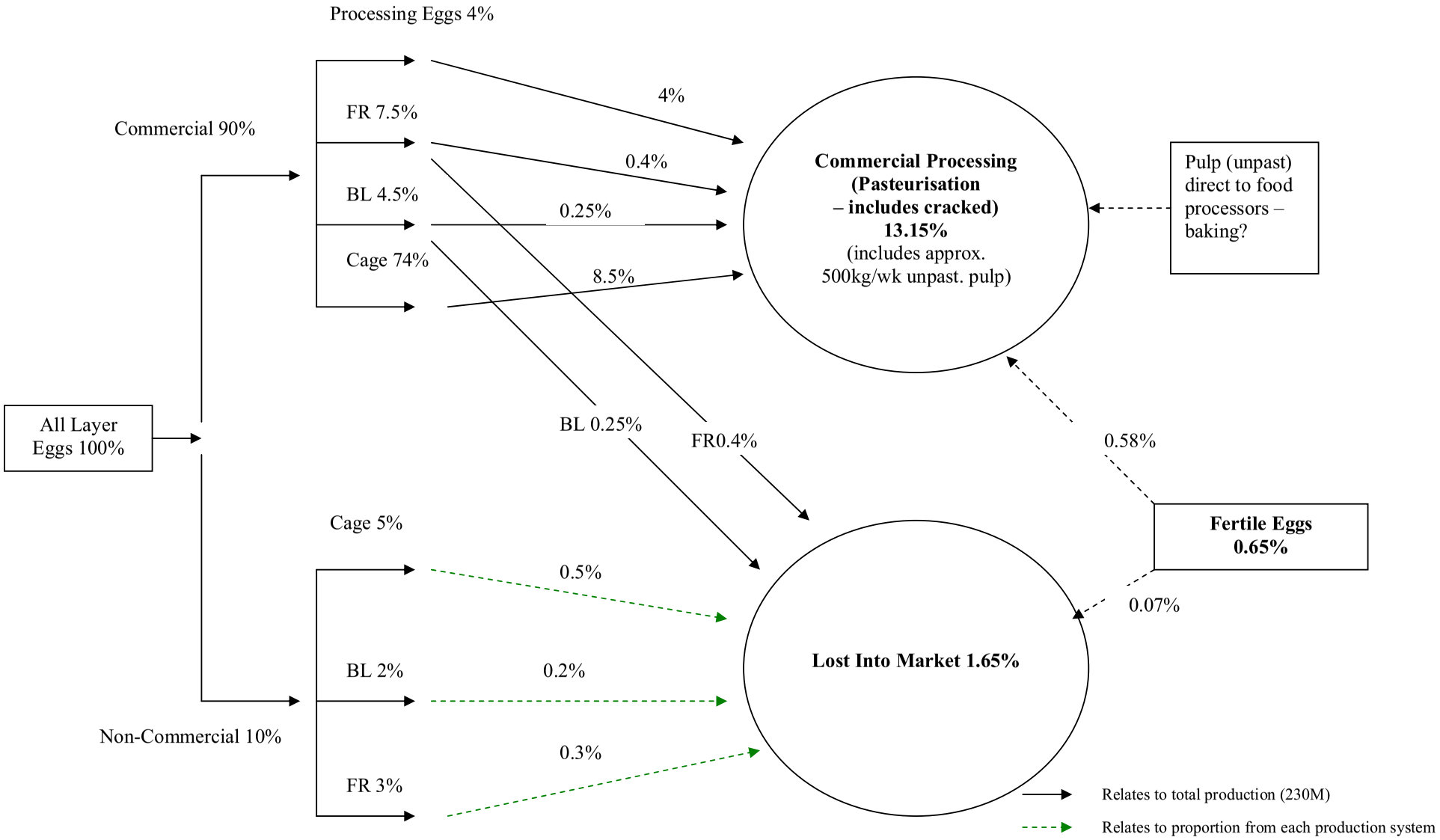
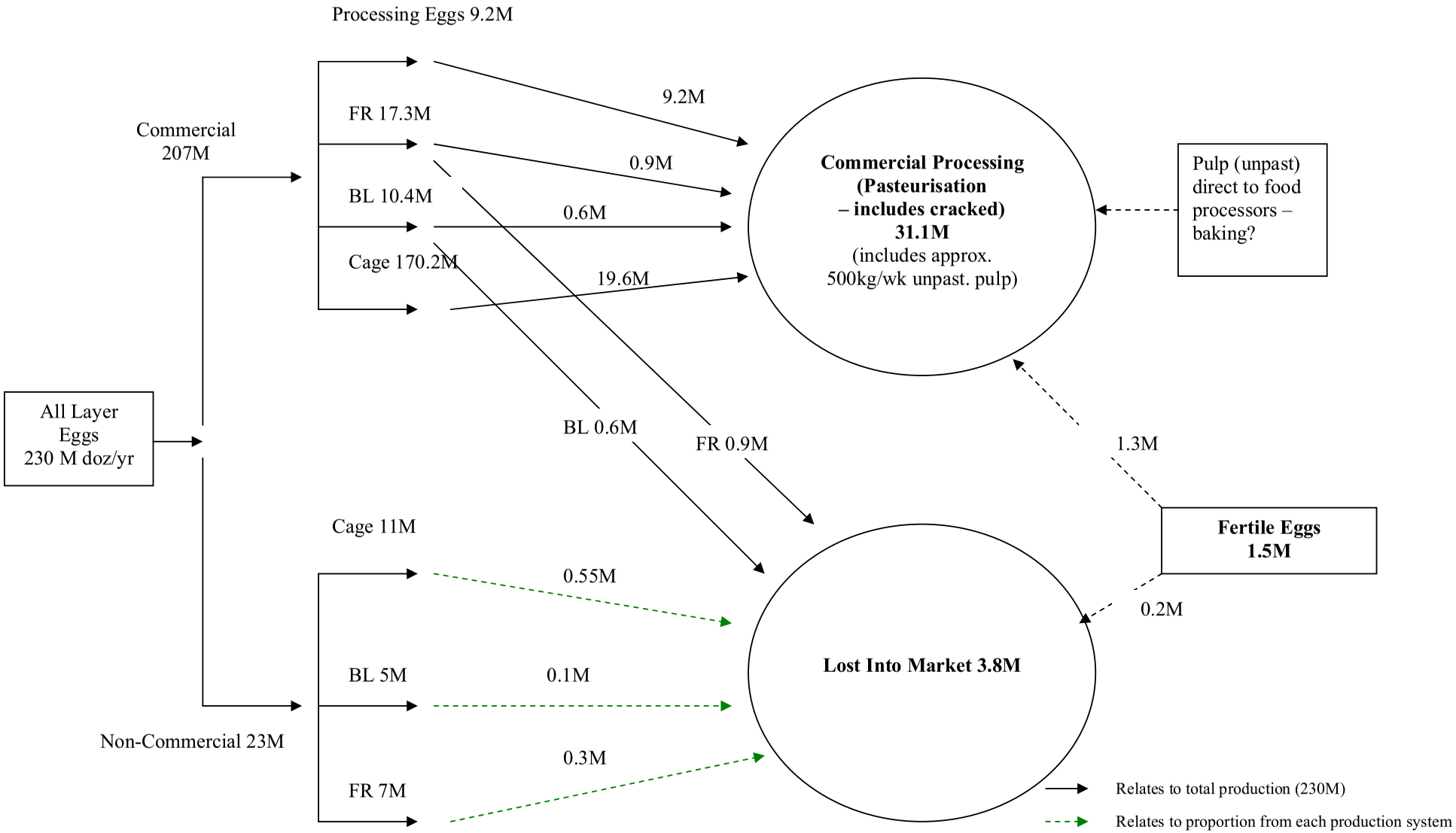


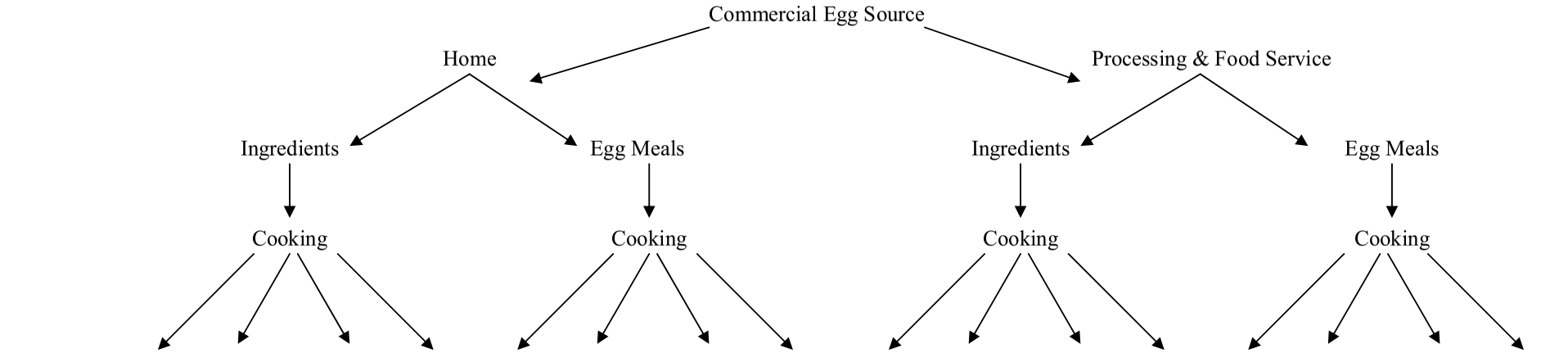
Figure 1.2. Egg Production Profile (Breakdown by Number)



Attachment 2

Preparation and End Use Pathways

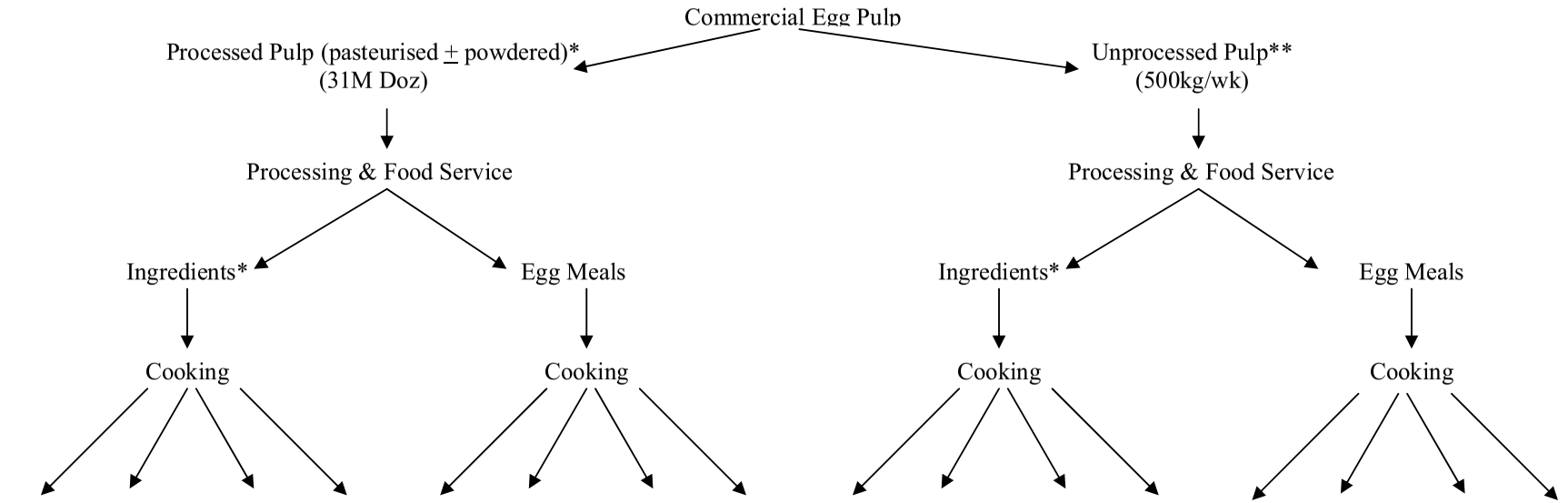
Figure 2.1: Potential Preparation and End Use Pathways for Commercially Produced Shell Eggs



Q11	NE	MR	SR	RE	NE	MR	SR	RE	NE	MR	SR	RE	NE	MR	SR	RE
Egg meal/ dish examples	-mayo -some desserts	-lightly cooked sauces -ice-cream -egg butter -meringue	-pasta	-cake -biscuit -bread -custard -pastry desserts -batter	-raw egg drink	-boiled 4 min -fried "sunny side up" -microwave (liquid yolk)	-fried "easy over" -scrambled med heat -omelette med heat	-scrambled high heat -boiled >8 min	-mayo -some desserts	-lightly cooked sauces -ice-cream -egg butter -meringue	-pasta	-cake -biscuit -bread -custard -pastry desserts -batter	-raw egg drink	-boiled 4 min -fried "sunny side up" -microwave (liquid yolk)	-fried "easy over" -scrambled med heat -omelette med heat	-scrambled high heat -boiled >8 min

NE – no effect
MR – moderately reduces (*Salmonella* counts ↓ 2 log)
SR – substantially reduces (*Salmonella* counts ↓ 5 log)
RE – reliably eliminates (*Salmonella* counts ↓ 8 log)

Figure 2.2: Potential Preparation and End Use Pathways for Commercially Produced Egg Pulp

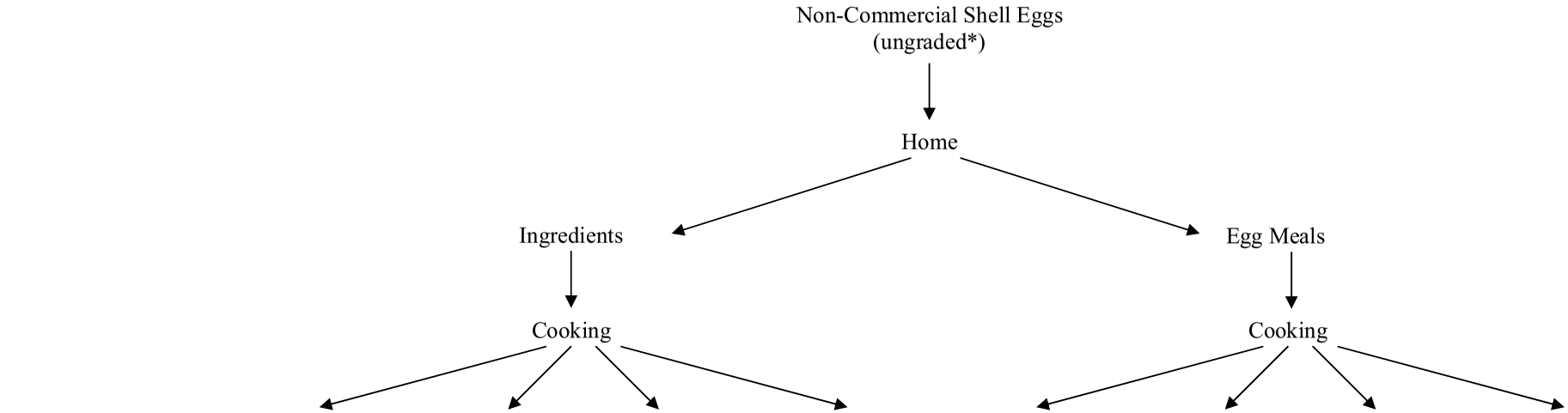


Q11	NE	MR	SR	RE	NE	MR	SR	RE	NE	MR	SR	RE	NE	MR	SR	RE
Egg meal/ dish examples	-mayo -some desserts	-lightly cooked sauces -ice-cream -egg butter -meringue	-pasta	-cake -biscuit -bread -custard -pastry desserts -batter			-scrambled med heat* -omelette med heat*	-scrambled high heat	-mayo -some desserts	-lightly cooked sauces -ice-cream -egg butter -meringue	-pasta	-cake -biscuit -bread -custard -pastry desserts - batter			-scrambled med heat* -omelette med heat*	-scrambled high heat*

* Assumed any positive batch detected/discarded
** Assumed pulped before YMT resolved. Consumer exposure in only one part of one state.

NE – no effect
MR – moderately reduces (*Salmonella* counts ↓ 2 log)
SR – substantially reduces (*Salmonella* counts ↓ 5 log)
RE – reliably eliminates (*Salmonella* counts ↓ 8 log)

Figure 2.3: Potential Preparation and End Use Pathways for Non-Commercial Shell Eggs



Q11	NE	MR	SR	RE	NE	MR	SR	RE
Egg meal/ dish examples	-mayo -some desserts	-lightly cooked sauces -ice-cream -egg butter -meringue	-pasta	-cake -biscuit -bread -custard -pastry desserts -batter	-raw egg drink	-boiled >4 min -fried "sunny side up" -microwave (liquid yolk)	-fried "easy over" -scrambled med heat -omelette med heat	-scrambled high heat -boiled >8 min

* proportion of contaminated meals adjusted for cracked eggs

NE – no effect
MR – moderately reduces (*Salmonella* counts ↓ 2 log)
SR – substantially reduces (*Salmonella* counts ↓ 5 log)
RE – reliably eliminates (*Salmonella* counts ↓ 8 log)

Attachment 3

Case for *Salmonella* Presence, Survival and Subsequent Growth in Internal Contents of Shell Eggs

The Defence Mechanism of the Egg

In normal healthy layers, the content of freshly laid eggs is sterile. In order to prevent microbial invasion of eggs and subsequent growth of micro-organisms in egg contents, eggs have three layers of anti-microbial defence (reviewed by Cox 2001). These are:

- The shell and its membranes
- The albumen
- Vitelline membranes

The shell represents a physical barrier against invasion by micro-organisms. Although this structure contains numerous pores of a size that potentially allow penetration by bacteria and viruses, the cuticle on the external surface, which forms within 3 minutes of lay (Sparks 1987; Sparks & Broad 1985) creates a protective barrier which encompasses about 97% of the egg surface. Together, the shell and the cuticle form an important first line of defence. Nevertheless, the shell does not eliminate the potential for contamination of the internal contents of eggs during egg formation and maturation within the ovaries, uterus and vagina of the hen. Furthermore, washing during processing can substantially disrupt, or completely remove the cuticle and as a consequence, compromise the integrity of the shell as a barrier.

Two membranes separate the internal surface of the shell and the albumen. These consist of microscopic fibres that represent a further physical barrier to micro-organisms.

The albumen contains chemical defence mechanisms that act to inhibit or prevent the growth of *Salmonella*, eg glycoprotein ovomucin, lysozyme, N-acetyl glucosaminidase, ovotransferrin and proteases. One of the most important chemical defences is ovotransferrin. Ovotransferrin accounts for ca. 18% of the total egg white solids and is largely responsible for the bacteriostatic activity of the albumen. This protein chelates iron (Fe^{2+}) with high affinity. Unless micro-organisms express other more effective iron scavenging proteins (eg *E. coli* O111), they will be unable to satisfy their growth requirements for iron and hence will be unable to grow. The stability of the iron-ovotransferrin complex is pH dependent; the higher the pH the more iron is bound. When eggs are freshly laid, the pH of the albumen is in the range 7 to 7.5, but within 3 days of lay, the pH increases to 9 to 9.5. At this pH, ovotransferrin has significant iron binding capacity and is strongly bacteriostatic for bacteria with a high iron requirement.

The vitelline membranes (the yolk membrane) consist of 2 fibrous layers that form a physical barrier. The outer layer also contains an insoluble lysozyme active against bacterial cell walls. As the membrane stability decreases with egg age, the ability of bacteria to penetrate these membranes increases, particularly at temperatures above 20°C (Whiting *et al*., 2000).

Vertical transmission of SE has been identified as a major route for the contamination of eggs in countries where SE is endemic in layer flocks. Studies into naturally contaminated eggs (Humphrey, 1991) established that the vitelline membrane or the albumen surrounding the membrane is the most likely location for SE cells in clean uncracked eggs. No evidence for direct yolk deposition was found in the 26 eggs examined. The number of SE cells found in naturally contaminated eggs was low (<20 cells/egg) for eggs stored at ambient conditions for up to 21 days at ambient temperatures (20-21°C). For eggs stored longer than three weeks, the number of cells in the eggs was found to increase. It was hypothesised that leakage of yolk contents, especially iron, into the albumen resulted in conditions that

allowed the growth of SE cells present. An alternative hypothesis was that *Salmonella* cells invaded the yolk through the weakened vitelline membrane, resulting in a rapid increase in numbers.

Evidence for non-SE in egg contents

The internal contents of eggs have been examined in many surveys for the presence of non-SE serovars (Attachment 6, Tables 6.2 and 6.3). Major studies have been conducted in the US, UK and Japan. From these surveys it is concluded that the prevalence of non-SE serovars in the contents of eggs is in the order of 0.004%. The most prominent serovars among these surveys were *S.* Typhimurium and *S.* Infantis, with the former accounting for approximately a quarter of isolates.

In comparison, in the same surveys, the prevalence of SE in contents was in the order of 10 times higher.

Keller *et al* (1997) and Okamura *et al* (2001) showed that although *S.* Typhimurium was able to colonise the ovaries of laying hens, it was not found in eggs post-lay. Further evidence for the transmission of *S.* Typhimurium in eggs is reported by Leach *et al* (1999) who exposed hens to *S.* Typhimurium DT 104 by oral and aerosol routes. Oral exposure resulted in 1.7% of 178 egg contents positive, while aerosol exposure resulted in 14% (n 145) and 25% (n 126) positive. The bulk of positive egg contents were recorded between 5 – 10 days post inoculation. In experimental studies (Nasim *et al* 1982) an eggshell strain of *Salmonella* Typhimurium was shown to penetrate the shell into egg contents at a rate of 54% when eggs (washed in saline) were held for one week at 25^0C at 85% humidity. Cox *et al* (2002) from experimental studies report shell penetration and growth in the yolk by both *S.* Infantis and *S.* Singapore after washing fresh laid eggs in 70% alcohol which would probably disrupt the defence of the cuticle (Sparks 1987; Sparks & Broad 1985). While differences between isolates were found in terms of their ability to reach the yolk the results indicate that if eggs are laid onto wet faeces contaminated with *Salmonella* before the protective effect of the cuticle is established, that contamination of contents is likely to be higher with dirty eggs. Ostlund (1971b) found no difference in penetration by *S.* Typhimurium between unwashed and machine washed eggs when the shell membranes were intact.

Cogan *et al* (2004) conclude that it is possible that "*S.* Typhimurium does not survive as well as Enteritidis in the forming egg, and that this explains the infrequent incidence of human Typhimurium via eggs". De Buck *et al* (2004) provides a comprehensive review of the colonisation of the chicken reproductive tract and egg contamination by *Salmonella.*

Growth of *Salmonella* in egg contents

There are two mechanisms for *Salmonella* to enter eggs: endogenous transmission following the infection of internal organs and exogenous transmission where *Salmonella* cells pass through the egg shell and internal membranes and into the albumen. Much of the research into the problem of *Salmonella* in eggs has focussed on the vertical transmission of SE into intact shell eggs. In the case of vertical transmission of *Salmonella* the principle site of infection appears to be the albumen or the vitelline (yolk) membrane.

Experimental evidence of the growth and persistence of *Salmonella* in albumen and yolk support the observations of the behaviour of *Salmonella* in naturally contaminated eggs. *Salmonella* inoculated into albumen grew very slowly, if at all. Lock and Board (1992) found that only 15/27 *Salmonella* serovars grew in albumen stored at 20°C. Generation (doubling) times ranged from 2 to 19 days. Of the remaining 12 serovars, only *S.* Pullorum did not remain viable at the end of 42 days of storage. Baron *et al*. (1997) identified ovotransferrin as the key compound responsible for inhibiting the growth of *Salmonella* in egg albumen.

Yolk by contrast to albumen is an excellent growth medium for *Salmonella* and does not contain the inhibitory compounds found in albumen. Growth of *Salmonella* in yolk is rapid compared with albumen; typical generation times of <2 hours at 25°C have been reported.

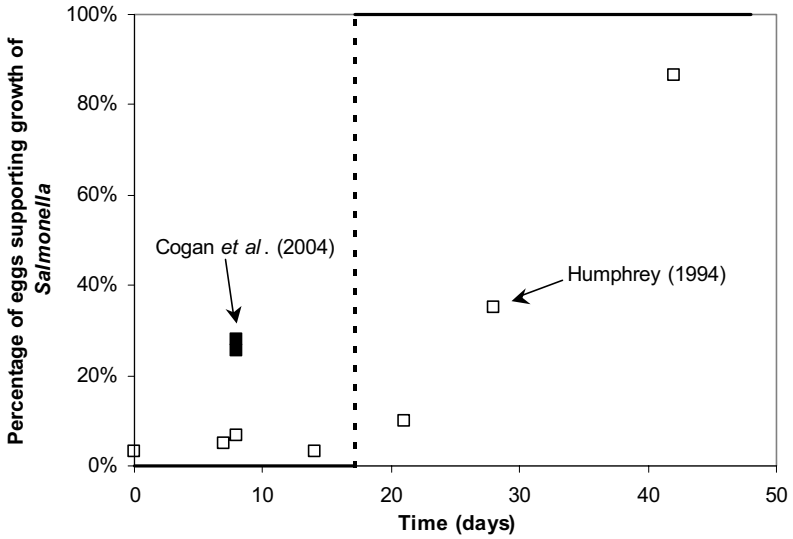
An important factor in estimating the risk to consumers of eggs is the time before growth of *Salmonella* in internally contaminated eggs. As reviewed previously egg albumen can inhibit the growth of *Salmonella*. However, growth in yolks is rapid at storage temperatures above 10°C. Humphrey (1994), Braun and Fehlhaber (1994) and Cogan *et al*. (2001) have studied the effect of temperature on the time before growth of SE inoculated into egg albumen. In particular, Humphrey (1994) found that the proportion of eggs that supported growth in the albumen (a thousand fold increase in 5 days) increased with the age of the egg (Figure 3.1, Open squares). After 7 days of storage only a small percentage of eggs supported growth in the albumen. For eggs stored for six weeks at 20°C, nearly 90% of eggs supported growth (Figure 3.1).

In a more recent study, Cogan *et al*. (2004) investigated the proportion of eggs supporting generalised growth of $>10^6$ cfu per ml. A viable cell count of $>10^6$ cfu/ml was considered indicative of yolk invasion. An albumen inoculum size of 2 cfu/egg was selected as it reflects the number of SE found in the albumen of naturally contaminated eggs (Humphrey *et al*., 1991). Inoculated eggs were stored at 20°C for 8 days. The results of these study was that over 25% of eggs inoculated with two *S.* Typhimurium strains (DT104 and SL1344 aroA transposon inserted) supported generalised growth after the 8 days storage. This result is comparable to the greatest proportion of eggs supporting growth of the SE phage types tested. Other SE phage types tested ranged between 5% and 15% of eggs with growth to high numbers. These results suggest the *S.* Typhimurium phage types may grow in egg earlier than found in the earlier studies using SE (Humphrey, 1994).

Potential for Growth in Yolk

Understanding the effect of storage temperature and time before the initiation of growth of *Salmonella* in egg contents is a key factor in assessing the risk from the consumption of eggs. Previous Quantitative Risk Assessments (QRA) for *Salmonella* Enteritidis in eggs (USDA-FSIS, 1998 and FAO, 2002) used the Yolk Mean Time (YMT) approach discussed in Whiting *et al*., (2000). The YMT was (arbitrarily) defined as the storage time when 20% of eggs supported growth in the albumen. The equation developed was based on experimental results for artificially contaminated eggs (Humphrey, unpublished; Humphrey, 1994). The dashed vertical line in Figure 3.1 is the predicted value (17.8 days at 20°C) from the USDA predictive YMT model. Note that before the YMT has expired it is assumed that no eggs would support the growth of *Salmonella*, while after the YMT all eggs are assumed to have experienced yolk invasion and the potential for generalised growth of *Salmonella*. The storage temperature of the egg controls the growth rate of the *Salmonella* in the yolk. Inspection of Figure 3.1 shows that the YMT approach underestimates risk prior to the expiry of the YMT, and overestimates the proportion of eggs supporting growth after the Yolk Mean Time. The results of Cogan *et al*. (2004) (Figure 3.1, full squares) suggest that the YMT may not reflect the behaviour of all *Salmonella* serovars in eggs, and would result in conservative risk estimates.

Figure 3.1. Relationship between time and susceptibility to support growth of *Salmonella* (SE) at 20^{0}C arising from artificial internal contamination (full squares - Cogan *et al*., 2004; empty squares - Humphrey, 1994; and solid and dashed line - USDA-FSIS, 1998).



The FAO SE in eggs QRA (FAO, 2002) suggested a modification to the USDA approach by including the possibility of yolk invasion during egg development. The result of the assumption of early yolk invasion was that about 3% of all eggs would support growth immediately after lay. The remainder of internally contaminated eggs follow the YMT equation. This modification in approach reflects the observed low proportion of artificially contaminated eggs supporting growth soon after inoculation. The issue of over estimating risk for storage times beyond the YMT is not dealt with. Alternative model forms are needed to accurately describe the observed behaviour of *Salmonella* growth in eggs.

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Attachment 4

Manufactured Egg Product Profile

The following data on end use of processed product were provided by the Australian commercial industry and represents approximately 65% of processed egg products produced nationally per annum.

Table 4.1: Manufactured egg product profile (Tonnes and %/yr for 65% of national commercial egg production)

Retail splits	AUST (65% production) T/yr	%
Whole pasteurised pulp	6,322	60.2
Pasteurised white	1,005	9.6
Pasteurised yolk	825	7.9
Pasteurised powder* whole	1,200	11.4
Pasteurised powder - white	750	7.1
Pasteurised powder - yolk	98	0.9
Boiled	188	1.8
Scrambled mix	112	1.1
	10,500	**100%**

* in Litres equivalents

End use split

Mayonnaise	10 - 15%
Biscuits	20 - 30%
Cake	50 - 55%
Pavlova (white)	8%
Ice cream (yolk)	1 - 2%
Boiled eggs	2.5%

Attachment 5

Excerpts from: "*A Strategic Study of the Interdependence and Integration of the Egg, Processed Food and Food Service Industries*"

Terry Larkin, Selwyn G Heilbron and Thomas Murphy
Rural Industries Research and Development Corporation. June 2001. RIRDC Publication No 01/18. RIRDC Project No: INS-4A

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2.21 Notwithstanding the significant fall in real egg prices, consumption of eggs has fallen gradually over the years. Falling egg consumption appears to be a feature in most other advanced developed countries resulting in part from health, lifestyle and convenience factors which will be discussed in later chapters. The following table provides recent data on per person consumption.

Year	Apparent consumption of eggs
1987-88	153
1988-89	146
1989-90	142
1991-92	144
1992-93	148
1993-94	139
1994-95*	135
1995-96	132
1996-97	132
1997-98	140
1998-99	137
1999-00	132
2000-01	145
2001-02	135

* (Source post 1994: AECL Annual Statistical Publication 2003 ISBN 1 920835 18 0)

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6.20 In this study key egg producers in each State were asked to provide estimates of the percentage of egg usage between households and various major egg using industry sectors. Unfortunately some key producers were not prepared to give any information on this issue. Those that did answer generally held the view that no one really knew for certain but six major producers from four States were prepared to provide estimates. There was considerable variation in the responses and most wanted confidentiality maintained. However, there was some broad consensus in the estimates.

For the smaller States, South Australia and Tasmania the estimates were:

Sector	Egg usage (%)
Households/retail	80%
Restaurants/fast	16%
Baking Product Manufacturing	2.50%
Cereals/Pasta	1%
Catering/transport	0.50%

There was a large range of estimates from four producers from Victoria, NSW and Northern NSW/Southern Queensland. These were:

Sector	Egg usage (%)
Households/retail	60-70%
Restaurants/fast	8-20%
Baking Product manufacturing	3-12%
Mayonnaise	0-4%
Ice cream/milk/baby food	0-0.5%
Confectionery	0-0.5%
Public sector hospital/defence	3-15%
Catering, transport	1.25-3%

These estimates can be compared to those provided by the ABS:

Sector	Egg usage (%)
Households/retail	91%
Restaurants/fast food/accommodation	8%
Baking product manufacturing	0.50%
Mayonnaise	<0.50%
Ice cream/milk/baby food	<0.50%
Confectionery	<0.50%
Public sector hospital/defence	<0.50%
Catering transport	<0.50%

6.21 The industry estimates need to be treated with considerable caution given the reservations of respondents and the absence of a complete response from all industry players. Nevertheless, the industry estimates are to be preferred to the ABS information. The industry information was therefore used to construct an indicative egg industry row for input-output analysis. The indicative row is the result of weighting the information provided from the industry according to the size of the State, supplier, the evidence used to support the estimate and rounding the figures as much as possible to avoid giving the impression of precision that is unwarranted. The resulting percentages of egg usage used to construct an egg row for Australia in the input-output table are shown in Table 16.

Sector	Egg usage (%)
Households/retail	65%
Restaurants/fast food/accommodation	15%
Baking product manufacturing	4%
Mayonnaise/other food	3%
Ice cream/milk/baby food (Dairy)	0.50%
Confectionery	0.50%
Health	5.00%
Defence	5.00%
Air/transport	1.00%
Cereals/Pasta	1.00%

Attachment 6

Prevalence of *Salmonella* spp on and in Shell Eggs

A pilot survey of the prevalence of (non-SE) *Salmonella* contamination of Australian eggs (Thomas and Daughtry unpublished) was conducted in 2002 to provide an indication of baseline prevalence for eggs.

Table 6.1: Pilot prevalence survey of *Salmonella* spp in commercial shell eggs

Egg type	Pilot prevalence 95% CI[A]			Overseas average (95% CI)
	Total tested	Sensitivity 0.7[B]	Sensitivity 1.0	
Shell eggs ungraded - external				
- Caged	2,160	0 – 0.2%	0 – 0.2%	0.21% (0.04- 0.62%)
- Free range [C]	1,200	0 – 0.4%	0 – 0.3%	
- Barn laid [C]	1,200	0 – 0.4%	0 – 0.3%	
Shell eggs - graded				
- Caged external	6,476	0 – 0.08%	0 – 0.06%	0.03% (0.01-0.07%)
- Caged internal contents	20,000	0 – 0.03%	0 – 0.02%	0.004% (0.001-0.008%)

[A] All cultures negative
[B] Assumes a 0.7 sensitivity due to culturing pools of 20 eggs
[C] Sample size for free range and barn laid too small to confidently estimate prevalence

All cultures were negative for *Salmonella*. By conservatively assuming the upper limit of the 95% Confidence Interval to be the estimate of the true prevalence, the results for contamination of external surfaces (for eggs from all production systems) reflects the average prevalence recorded internationally for non-SE serovars. This applies to both ungraded and graded (washed) eggs.

For internal contents, insufficient eggs were tested in the pilot study to obtain a rigorous estimate, though the prevalence may be assumed to also reflect international levels considering the low and similar prevalence of external contamination.

Prevalence surveys for salmonellae in egg contents

A summary of overseas prevalence surveys of salmonellae in egg contents is presented in Tables 6.2 and 6.3. The ratio between the prevalence of *Salmonella* (non-SE) contamination of the shell surface of ungraded eggs and contamination of contents of ungraded and graded eggs can be inferred from data in Table 6.2, as approximately 50:1 and 100:1, respectively. Similar data for barn laid and free range eggs is unavailable. This would be useful in assisting risk assessment of eggs laid from these alternative production systems (see Section 5.1).

Non-SE prevalence and serovar (Table 6.4) information from the larger surveys provides the most representative data. For the purposes of the Risk Profile it is proposed that a prevalence of 0.004% for non-SE *Salmonella* in contents of eggs is used.

Prevalence surveys for *Salmonella* in non-chicken avian eggs

A summary of surveys of *Salmonella* in duck and quail eggs across several countries is reported in Table 6.3. Prevalences are considerably higher than reported for chicken eggs, supporting the anecdotal view that duck eggs present a greater risk.

Table 6.2: Summary of the prevalence of *Salmonella* on egg shells and in egg contents for samples taken from retail and production environments.

Sample type	Source	Study	Non-SE		SE	
			+/total	Prev % (95% C.I.)[1]	+/total	Prev % (95% C.I.)[1]
Shells	Off-farm	Baker	3/1400	0.21 (0.04, 0.62)		
		Humphrey			21/1952	1.1 (0.7,1.6)
		Perales			4/372	1.1 (0.3,2.7)
		Perales			5/998	0.5 (0.2,1.1
					0.9% (0.5, 1.4)[2]	
	Retail	de Louvois	17/83820	0.02 (0.01,0.03)	103/83820	0.12 (0.10,0.15)
		Wilson	6/12540	0.05 (0.02,0.10)	2/12540	0.02 (0.002,0.06)
		Schutze	1/1200	0.08 (0.002,0.46)	0/1200	0 (0,0.31)
			0.03% (0.01,0.07)[2]		*0.04% (0.01,0.21)*[2]	
Contents	Off-farm	Shirota	16/284715	0.006 (0.003,0.009)	6/284715	0.002 (0.001,0.005)
		Schlosser	20/647000	0.003 (0.002,0.005)	178/647000	0.028 (0.024,0.032
		Saeed			63/140000	0.045 (0.035,0.058
		Humphrey			18/1952	0.92 (0.56,1.43)
		Perales			1/372	0.27 (0.01,1.49)
		Perales			1/998	0.10 (0.01,0.56)
			0.004% (0.003,0.005)[2]		*0.06% (0.01,0.34)*[2]	
	Retail	de Louvois	2/83820	0.002 (0.0003,0.009)	16/83820	0.02 (0.01,0.03)
		Wilson	0/12540	0 (0.00,0.03)	1/12540	0.008 (0.0002,0.044)
			0.002% (0.001,0.008)[2]		*0.018% (0.011,0.028)*[2]	

[1] Prevalences and Fisher's Exact 95% confidence intervals for each study were estimated using PEPI Describe (V0.12).

[2] Population averaged prevalence was estimated by "intercept only" 2-level hierarchical random effects logistic regression using restricted penalised quasi-likelihood estimation (HLM Version 5.04).

Table 6.3: Summary of the prevalence of *Salmonella* in egg contents for samples taken from retail and production environments.

Sample type	Source	Study	Non-SE		Serovars and comments
			+/total	Prev % (95% C.I.)[1]	
Contents	Off-farm	Shirota* Japan	16/284715	0.006 (0.003,0.009)	16 commercial farms Naturally infected flocks Pool size: Contents and shells 20 (74800 eggs) Contents – pool size 333 (1000/3) (~284715 eggs) *S.* Infantis 8 isolates *S.* Bareilly 2 isolates *S.* Livingston 1 isolate Untypable 5 isolates
		Schlosser* US	22/647000	0.003 (0.002,0.005)	Commercial flocks Pool size: 10 or 20 eggs Assumption that a positive pool contained only a single positive egg *S.* Montevideo 5 isolates *S.* Kentucky 5 isolates *S.* Cerro 2 isolates *S.* Typhimurium 1 isolate *S.* Tennessee 1 isolate *S.* Dublin 1 isolate Untyped *Salmonella* serovars 7 isolates
		Saeed US	10/140000	0.007	Commercial flocks (Mid Western states) *S.* Typhimurium 8 isolates *S.* Heidelberg 2 isolates
		Humphrey UK	0/1952	0	
		Indar Trinidad	3/750		*S.* Typhimurium 3 isolates
		Radowski Poland	0/1200	0 (0: 0.31)	Eggs purchased from local markets
			**0.004% (0.003,0.005)*[2]		
	Retail	de Louvois* UK	2/83820	0.002 (0.0003,0.009)	Commercially purchased eggs Pool size = 6 (83820 eggs) non-SE Salmonella spp. = 2
		Wilson* N Ireland	0/12540	0 (0,0.03)	Commercially purchased eggs Pool size 12 (1200 eggs)
		Schutze US	0/1200	0 (0: 0.31)	Commercially purchased eggs Pool size 12 (1200 eggs)
			**0.002% (0.001,0.008)*[2]		

[1] Prevalences and Fisher's Exact 95% confidence intervals for each study were estimated using PEPI Describe (V0.12).

[2] Population averaged prevalences were estimated by "intercept only" 2-level hierarchical random effects logistic regression using restricted penalised quasi-likelihood estimation (HLM Version 5.04).

Table 6.4: Prevalence of *Salmonella* spp. from non-chicken avian eggs

Non-chicken avian species	No. of eggs tested	% Pos for *Salmonella*	*Salmonella* serotype and phage type	Comment	Country	Reference
Duck Egg - Shell surface	2256	12.4	23 including *S* Typhimurium *S*. Cerro *S*. Tennessee *S*. Amsterdam *S*. Agona *S*. Infantis	retail markets	Thailand	Saitanu *et al* 1994
	50	14.0	not stated	source unknown	India	Ghosh *et al* 2002
	15	0.0	not applicable	domestic	Croatia	Miokovic *et al* 2003
	100	8.0	*S*. Typhimurium *S*. Montevideo	free range	Iraq	Shareef *et al* 1997
	102	4.9	*S*. Anatum *S*. Oranienburg *S*. Paratyphi B	source unknown	India	Chowdhury *et al* 1976
	544	5.1	*S*. Enteritidis *S*. Hadar	breeder farms	United States	Baker *et al* 1985
Duck Egg - Content	2256	11.0	as for shell surface	retail markets	Thailand	Saitanu *et al* 1994
	15	0.0	not applicable	domestic	Croatia	Miokovic *et al* 2003
	90	4.3	not stated	clean eggs	Bangladesh	Ali *et al* 1987
Quail Egg - Content	1152	0.6	*S*. Typhimurium *S*. Hadar	includes dead in-shell embryos and infertile eggs	Egypt	Fatma *et al* 2001
	123	5.7	*S*. Enteritidis	not stated	Turkey	Erdogrul *et al* 2002

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Attachment 7

Egg Handling Time:Temp Data in Australia (2002)

Data on the time and temperature eggs were held on farm in Australia in 2002 was collected as part of the Quantitative Risk Assessment for *Salmonella* in eggs (AECL Project SAR-42A). Data was obtained by telephone interview conducted by expert consultants to the egg industry. The data below covers 52 commercial layer facilities in 4 states.

Table 7.1: Time eggs held on farm (caged hens only)

Flock Size	Time (hours) eggs held on farm		
000's	min	ave	max
>250	24	24	36
20 - 49	24	60	96
5-19	24	48	84
20-49	24	36	48
20-49	15	24	48
5-19	24	60	96
20-49	18	24	36
20-49	2	84	168
20-49	36	48	144
50 - 99	24	60	144
5-19	24	72	168
20-49	24	60	96
5-19	24	96	120
5-19	24	60	120
5-19	48	72	108
5-19	24	72	144
100 - 249	24	96	168
100 - 249	6	12	24
100 - 249	24	72	96
20-49	24	72	96
5-19	24	72	144
5-19	24	72	144
5-19	72	84	96
5-19	24	72	72
5-19	36	84	132
5-19	24	84	144
5-19	24	96	288
5-19	24	60	72
5-19	48	60	120
5-19	24	84	168
5-19	24	72	168
5-19	24	60	120
5-19	24	72	192
<5	48	84	168
n/a	6		48
20-49	12	48	72
50 - 99	12	48	70
50 - 99	6		48
5-19	24	72	120
5-19	12		72
100 - 249	6		24
20-49	1		120
100 - 249	3		48
50 - 99	2		168
20-49	24		72
100 - 249	4	6	36
50 - 99	6	24	48
20-49	6	24	48
100 - 249	4	6	36
100 - 249	0	4	24
>250	24	60	96
100 - 249	3	15	60

Table 7.2: Egg storage temperature on farm (caged hens only)

Egg storage temperature (on farm)

Flock size	Temperature Summer deg C			Temperature Winter deg. C		
000s	min	ave	max	min	ave	max
>250	ambient	ambient	ambient	ambient	ambient	ambient
20 - 49	10	10	10	10	10	10
5-19	13	14	15	13	14	15
20-49	15	15	15	15	15	15
20-49	10	13	15	10	13	15
5-19	10	12	14	10	12	14
20-49	4	4	4	4	4	4
20-49	4	7	14	4	7	14
20-49	10	10	10	10	10	10
50 - 99	11	13	15	11	13	15
5-19	11	12	13	11	12	13
20-49	11	12	13	11	12	13
5-19	12	13	14	12	13	14
5-19	7	8	9	7	8	9
5-19	ambient	ambient	ambient	ambient	ambient	ambient
5-19	10	12	14	10	12	14
100 - 249	15	16	17	15	16	17
100 - 249	7	7	7	7	7	7
100 - 249	14	16	18	12	14	16
20-49	12	13	14	ambient	ambient	ambient
5-19	11	13	16	11	13	16
5-19	13	15	19	13	15	19
5-19	13	16	19	13	16	19
5-19	14	16	19	14	16	19
5-19	14	16	19	10	14	16
5-19	12	14	16	12	14	16
5-19	13	14	15	13	14	15
5-19	10	12	16	10	12	16
5-19	12	14	16	12	14	16
5-19	12	14	16	11	13	15
5-19	13	14	16	11	13	15
5-19	10	***11.5***	13	10	***11.5***	13
5-19	10	13	16	10	13	16
<5	10	13	16	10	13	16
5-19	18	***18***	18	18	***18***	18
20-49	18	***19***	20	ambient	***ambient***	ambient
50 - 99	13	16	20	13	16	20
50 - 99	13	16	20	13	16	20
5-19		12	20		16	ambient
5-19	18	19	20	18	***19***	20
100 - 249	12	12	12	ambient	***ambient***	ambient
20-49	15	15	20		15	20
100 - 249	14	***17***	20	14	***17***	20
50 - 99	18	***18***	18	18	***18***	18
20-49	18	***19***	20	12	***15***	18
100 - 249	13	17	20	10	15	17
50 - 99	13	17	20	10	15	17
20-49	13	17	20	10	15	17
100 - 249	13	17	20	10	15	17
100 - 249	12	***15***	18	12	***15***	18
>250	12	***15***	18	12	***15***	18
100 - 249	12	***16***	20	12	***16***	20

Bold italic numbers are average of minimum and maximum reported temperatures

Attachment 8

Data on Time and Temperature During Egg Grading Floor Storage in Australia (2002)

Data on the time and temperature during egg grading floor storage in Australia in 2002 was collected as part of the Quantitative Risk Assessment for *Salmonella* in eggs AECL Project SAR-42A. Data was obtained by telephone interview conducted by an egg industry quality assurance expert. The data below covers 8 egg grading floors in 5 states.

Table 8.1: Storage temperature and time in 8 grading floors in 5 states

Egg Processor	Storage temperature ^{0}C			Storage time* (hrs)		
	Min.	Most likely	Max.	Min.	Most likely	Max.
1	12	15	18	0	24	240
2	12	16	18	24	240	504
3	14	15	16	24	72	144
4	12	15	17	24	96	144
5	10	11	12	36	48	144
6	7	10	15	n/a	n/a	n/a
7	12	14	16	12	36	240
8	13	16	18	0	24	72

* Storage time pre-grading (assume marketed within 1-2 days after grading)

Attachment 9: Hazard Sheets

9.1 *Salmonella* spp.

Hazard identification

See Part 1 Section 3.1

Hazard characterisation

See Part 1 Section 3.2

Exposure assessment

Exposure of livestock

Layer flock serovars
The profile of *Salmonella* serovars isolated from the routine monitoring of the environment of flocks for SE freedom in NSW is shown in Table 9.1.1 (these isolates are not included in the NEPSS data for the same period). In this scheme 3 colony picks are evaluated for each positive plate; if initial identification indicates multiple strains all 3 are sent to the IMVS for serotyping. Multiple serovars have been isolated concurrently from Australian layer flock environments (Cox, 1993), though the low incidence of *Salmonella* recorded in NSW flocks suggests this to be unlikely in most instances.

The sensitivity of monitoring the layer environment to detect *Salmonella* has been reviewed by Sergeant *et al.,* (2003) who states, "NSW Agriculture currently manages the SE Monitoring and Accreditation Scheme for layer and breeder flocks in New South Wales (Anon, 1999). This scheme is based on the use of drag-swabs, with usually about five swabs collected per shed and cultured in pools of up to five swabs/pool. For a "Monitored " status, flocks must be tested on a monthly basis with negative results. "Accredited" status requires implementation of additional biosecurity and risk-management measures, and Accredited flocks may progress to three-monthly testing, subject to certain conditions. For breeder farms, individual sheds are being sampled and treated under the scheme separately, as individual flocks, although this is not a specific requirement.

Assuming an average of 10-15 swabs per layer flock and five swabs per breeder shed, and that one swab is equivalent to culture or serology on 50 birds (Kingston, 1981), this sampling regime provides 95% confidence of detecting a within flock prevalence of about 0.5% in layer flocks and about 1% in a breeder shed". This is the approach that has been recommended to AECL as the preferred method for the proposed national SE monitoring program (Sergeant *et al.,* 2003), "a standard higher than that recommended in the International Animal Health Code of the World Animal Health Organisation (Office International des Epizooties)".

Data over 3 years from NSW found only 3.1% (2.4%-3.9%, 95% CI) of 2252 monthly shed drag swab tests were positive (Table 9.1.1), with only 8.7% (3.3%-18.0%, 95% CI) of these 69 shed test positives with the same serovars at the following monthly test.

A low isolation rate in Queensland flocks was also reported (Cox, 1993; Cox *et al.,* 2002), however, these data do not represent a systematic survey of industry, but is the best available published data. *Salmonella* serovars were isolated in feed and the animal protein meals in use, and it was concluded that these serovar incursions were transient rather than representative of longer-term colonisation of the layer flock. This is supported by the data from routine flock environment monitoring in NSW.

Stockfeed serovars

Potential exists for introduction of *Salmonella* serovars into layer flocks via contaminated stockfeeds. A review of 5 years of testing of animal feedstuffs and stockfeeds by NEPSS (1998-2002) reveals 2,683 isolates of *Salmonella*. Of these isolates only 0.8% was *S.* Typhimurium, all being isolated in 2001 predominantly from meat and bone meal. This low isolation rate of *S.* Typhimurium is consistent with the NSW (Table 9.1.1) and Qld flock environment data (Cox, 1993; Cox *et al.,* 2002).

The most commonly isolated serovars from animal feedstuffs in recent years (NEPSS, 2000-2002) include *S.* Orion var 15+, *S.* Agona, *S.* Anatum and *S.* subsp I ser 4,12:d:-. Over this period these serovars were also isolated from pelleted stockfeeds. The potential for flock and egg contamination from serovars entering the flock via contaminated feed is inferred from the isolation of the same serovars from layer flocks environment (Table 9.1.1) and raw egg products (Table 9.1.4) recorded over the same 3 year period.

In comparison, *S.* Typhimurium is only rarely isolated in relation to other serovars from layer flock environments (Table 9.1.1; Cox *et al* 2002), but is relatively common in comparison to other serovars in raw egg pulp (Table 9.1.4) and in outbreaks in which eggs are included in the implicated food (Part 1 Section 3.1).

Cox (1993) also reported a low incidence of flock environment contamination in Queensland, with serovars reflecting those found in feeds and animal protein meals used at the time. Overall, common serovars found in pulp reflected those found commonly in the layer environment during the study period (Cox *et al.,* 2002).

Table 9.1.1: *Salmonella* serovars isolated from layer flock environments in New South Wales 2000-2003

***Salmonella* Serovar**	**Isolates from NSW SE monitoring scheme 2000-2002[1]**			
	2000 (48 farms, 822 shed tests)	**2001 (44 farms, 804 shed tests)**	**2002 (42 farms, 626 shed tests)**	**NSW Total (48 farms, 2252 shed tests)**
Agona[2, 3]	7	1	2	10
Bovismorbificans	1			1
Give				
Havana[3]				
Infantis[2, 3]	4	1	1	6
Kiambu[2]				
Kottbus		1		1
Livingston		1	3	4
Mbandaka[2, 3]				
Muenchen				
Ohio[2, 3]			1	1
Orion[2, 3]	2	1	1	4
Senftenberg [2, 3]	4	3	1	8
Singapore[2, 3]			1	1
Sofia	7		8	15
Tennessee[2]	1		2	3
Typhimurium untypable		2		2
subsp. 1 ser 3,19:-:-		3		3
subsp 1 ser 4,12:d:-[3]			10	10

[1] Data from IMVS serotyping

[2] Relatively commonly isolated from stock feeds compared to other serovars; meat meal and meat and bone meal predominantly (NEPSS, 2000-2002)

[3] Isolated from layer flocks in Queensland (Cox, 1993; Cox *et al.,* 2002)

Exposure of Product

A Pilot Prevalence Survey of *Salmonella* spp. Contamination of Fresh Laid Table Eggs was conducted to provide a preliminary indication of shell egg (external and internal) contamination by Ben Daughtry (SARDI), Geoff Holds (SARDI), Francesca Bell (Adelaide University), David Jordan (NSW Agriculture), George Arzey (NSW Agriculture), Connor Thomas (Adelaide University) and Andrew Pointon (SARDI) (unpublished).

The following is an excerpt from the unpublished report on this survey:
In recent decades foodborne problems caused by *Salmonella* contamination of eggs has risen in overseas countries due mainly to infection by *Salmonella* Enteritidis phage type 4 (SE) in egg contents. While major outbreaks have occurred due to *S.* Typhimurium contaminated eggs in Australia, SE has not been isolated from shell eggs here.

Despite the apparent absence of endemic SE, public health regulators are establishing commodity standards for primary production and processing, including eggs. State agencies responsible for implementing appropriate controls are reviewing arrangements for eggs. In addition, developments in the global trade of food have exposed egg producers to a new set of opportunities and risks that are best managed with risk assessment. Estimating 'equivalence' is now the process used to determine whether or not Australian egg products can penetrate foreign markets, and whether or not egg products produced abroad can penetrate Australian markets.

However, the level of contamination of eggs in Australia is currently uncertain. A necessary first step in determining the risk is to determine the prevalence of *Salmonella* serovars on and in eggs both off farm and ex-factory.

The objectives of this study were to:

- conduct a literature review of the occurrence of *Salmonella* on and in eggs, and the methods for estimating prevalence of *Salmonella* on and in eggs, and
- interpret the findings from the survey and
- to estimate the prevalence from the literature and survey to guide the quantitative risk assessment.

Due to the 1 year term of the risk assessment project, a short-term pilot prevalence survey was undertaken to provide prevalence input data for the risk assessment model.

These aims were achieved by surveying the prevalence of *Salmonella* spp. on the external surface of eggs submitted for table egg grading at the point of delivery to factory and both internal and external contamination of first grade shell eggs post factory. The study used eggs of both categories (ex-farm and ex-factory) sourced from farms chosen to represent current caged commercial production systems. Such data is not otherwise available for the Australian egg industry.

To best represent consumer exposure, eggs were selected from farms from each flock size (category) with egg numbers reflecting the pro rata production from the flock-size category rather than the number of farms in the category. Eggs were cultured in 20 egg pools and tested using the Australian Standard Method AS1766.2.5, 1991. A total of 31,036 eggs were cultured for *Salmonella* contamination including; off-farm/ungraded external (2,160), graded external (6,476) and graded contents (20,000). All graded eggs sampled had been washed.

The estimated prevalence of *Salmonella* on and in eggs (Table 9.1.2) was found to be:

- Caged, Off-farm/ungraded external surface (2160 eggs) – 0% (95% C.I.; i.e. between 0 to 0.2%)
- Caged, Graded (washed) external surface (6476) – 0% (0, 0.06%)
- Caged, Graded contents (20000) – 0% (0, 0.02%)

Table 9.1.2: Pilot prevalence survey of *Salmonella* spp in commercial shell eggs

Egg type	Pilot prevalence 95% CI[A]			Overseas average (95% CI)
	Total tested	Sensitivity 0.7[B]	Sensitivity 1.0	
Shell eggs ungraded - external				
- Caged	2,160	0 – 0.2%	0 – 0.2%	0.21% (0.04- 0.62%)
- Free range [C]	1,200	0 – 0.4%	0 – 0.3%	
- Barn laid [C]	1,200	0 – 0.4%	0 – 0.3%	
Shell eggs - graded				
- Caged external	6,476	0 – 0.08%	0 – 0.06%	0.03% (0.01-0.07%)
- Caged internal contents	20,000	0 – 0.03%	0 – 0.02%	0.004% (0.001-0.008%)

[A] All cultures negative
[B] Assumes a 0.7 sensitivity due to culturing pools of 20 eggs
[C] Sample size for free range and barn laid too small to confidently estimate prevalence

All cultures were negative for *Salmonella*. By conservatively assuming the upper limit of the 95% Confidence Interval to be the estimate of the true prevalence, the results for contamination of external surfaces (for eggs from all production systems) reflects the prevalence recorded internationally for non-SE serovars. This applies to both ungraded and graded (washed) eggs.

For internal contents, insufficient eggs were tested to obtain a rigorous estimate, though the prevalence may be assumed to also reflect international levels considering the low prevalence of external contamination.

The pilot survey provides baseline prevalence for contamination of eggs by non-SE serovars in Australia that is comparable with overseas studies.

Shell eggs and processed egg serovars
A summary of laboratory testing of shell eggs and processed eggs at the Institute of Medical and Veterinary Science (IMVS) in SA is provided in Table 9.1.3, while the positive isolates reported to NEPSS from raw eggs and egg products are in Table 9.1.4. Data from NEPSS (2000-2003) represents isolates from raw eggs, processed egg product, foods containing eggs and egg processing equipment submitted for serotyping at MDU. The majority of these isolates originate from Victoria. The bulk of isolates are from a range of raw egg products, with *S.* Singapore, *S.* Cerro and *S.* Typhimurium being the most commonly isolated serovars (Table 9.1.4). Isolates from foods investigated in outbreaks are included in these data.

In addition, as part of this project, five egg processors across Australia were surveyed for the frequency of testing for the presence of *Salmonella* in liquid egg products. The processors reported sampling between two and 10 times per week, depending on the quantity of liquid egg pasteurised.

Data from 1976 reveals contamination of bulked unpasteurised liquid egg was common (15% of batches) with a broad range of serovars (n=29) (Peel 1976).The main serovars isolated in egg pulp surveys in Queensland in the 1990s were *S.* Singapore, *S.* Mbandaka, *S.* Cerro and *S.* Infantis (Cox *et al* 2002). National data covering the period 2000 to 2003 (Table 9.1.4) is consistent with this earlier Queensland data. Contamination of raw whole egg sampled over 14 months at single egg processing facility in Queensland was very high (95% of 110 samples), presumably due to pooling across farms. In contrast 23% of 856 farm egg pulp samples were positive indicating contaminated pulp from a single farm may contaminate the rest of the pulp. The isolation of *S.* Infantis, particularly from egg

yolk product, is of concern due to its public health significance in other countries (Cox *et al* 2002). However, the frequency of isolation was found to be low relative to other serovars, and this appears to be the situation in recent NEPSS data (Table 9.1.4). Concerns raised in relation *S*. Infantis have not materialised to date as outbreaks attributed to *S*. Infantis, or to egg pulp: *S*. Infantis combinations have not been reported in Australia (Part 1 Section 3.1). While NEPSS data are not based on any statistical sampling basis and tested pulp may not always be limited to eggs from commercial layers, the qualitative impact of *S.* Typhimurium was considered sufficiently important to identify this organism as the target pathogen of concern in egg products.

More recent data over a 3 month period from the IMVS (2004) reveals 85% of 27 raw egg pulp samples positive for *Salmonella*. The isolates include 8 x Singapore, 7 x Typhimurium PT108, 4 x Typhimurium PT9, 2 x Oranienburg, 1 x Anatum and 1 x Mbandaka. *S*. Typhimurium PT9 in particular is also a relatively common serovar in NEPSS data from raw egg pulp (Table 9.1.4) and has been implicated in outbreaks (Part 1 Section 3.1). Data on isolates from commercial raw egg pulp samples from the first 6 months of 2005 reveals a broad range of serovars, including a number of *S.* Typhimurium Phage Types listed in the outbreaks summarised in Attachment 11 (Murrary 2005a,b). While this commercial product testing data does not allow estimation of prevalence, it raises the potential of flock infection with *S.* Typhimurium in areas other than Qld and NSW (see above). Alternatively, this may reflect pulp contamination post-farm gate from sources other than eggs; in Risk Assessment terms this remains an area of uncertainty.

Egg processing equipment serovars
In the period 2000-2002, 33 isolates from egg processing equipment reported to NEPSS (J Powling pers. comm. 2003) were recorded (*S*. Agona 9 isolates, Broughton 3, Infantis 16, Ohio 1, Singapore 3, Virchow PT34 1). Four of these serovars were also isolated from pasteurised egg product highlighting the potential for either processing failure or post-processing recontamination (Table 9.1.4).

Table 9.1.3: IMVS Food Lab *Salmonella* testing of shell eggs and processed eggs (1998-2004)

Product	Year(s)	Number of samples	Number of samples in which *Salmonella* was detected	Reference
Eggs & processed eggs*	Jan 1998-Dec 2001	339	0	Murray (2002)
Processed egg*	Jan-Dec 2002	41	0	Murray (2003a)
Egg (AQIS)	Jan-Dec 2002	27	0	Murray (2003a)
Raw egg pulp**	Jan-March 2003	6	2***	Murray (2003b)
Raw egg pulp	April-June 2004	27	23****	Murray (2004)

* pasteurised egg product
** commercial unpasteurised pulp, not outbreak related
*** *S*. Bovismorbificans PT24
**** Includes 7x *S*. Typhimurium phage type 108 and 4 x *S*. Typhimurium phage type 9

Table 9.1.4: *Salmonella* isolates and phage types from eggs, processed egg and egg products and notified to NEPSS from laboratories across Australia over the period 2000-2003 (Source NEPSS, Non-human data)

Salmonella Serovar	Egg and Egg Product Type									
	Raw Egg Pulp	Raw Egg White /White Mix	Raw Egg Yolk	Egg Powder / Whole Egg Powder	Boiled Egg	Scrambled Egg	Pasteurised Egg Pulp	Pasteurised (Salted) Egg Yolk	Egg Unspecified	Egg Product (mainly Mayonnaise)
Agona*	5						1			
Anatum*	4									
Bovismorbificans PT24	2**									
Cerro*	1	11					2			
Infantis*	2							1		
Johannesburg	1									
Kiambu*		1								
Mbandaka*	2				1					
Ohio*	6						2	2		
Oranienburg	1									
Orion*	2									
Singapore	3	1		23						
Tennessee*						1				
Typhimurium PT8										1
Typhimurium PT 9	13	2						2		13
Typhimurium PT 102				1						
Typhimurium PT 126										3
Typhimurium PT 135	3	7	3				1		3	3
Typhimurium PT 170				1						
Typhimurium RDNC	1									
Typhimurium untype	9							1		
Virchow PT 34	7		1	2				1		
Subsp 1 ser 1,3,19:-:-	1									
Total Isolates	**63**	**22**	**4**	**27**	**1**	**1**	**6**	**7**	**3**	**20**

* Relatively commonly isolated from stock feeds compared to other serovars, meat meal and meat and bone meal predominantly (NEPSS 2000-2002)

** Same S. Bovismorbificans phage type 24 as reported by IMVS in 2003

Exposure of Humans

See Attachment 11.

Current Controls and Monitoring

See Mitigations (Attachment 14)

Recommendations

Throughout AECL Project SAR-42A and this project a lack of consensus in relation to attribution criteria was apparent. Suggestions in addition to the issues identified in the Hazard Identification section are listed.

- The national industry is promoting the concept of a national SE (freedom) monitoring program similar to the NSW program. This would provide data on any regional differences and a wider perspective on industry serovars, phage types and flock incidence.
- In our work it has become apparent that not all isolates from industry QA monitoring are submitted for typing. This represents a "loss" of useful information.
- New molecular techniques (eg Multi-Locus Sequence Typing) may offer assistance in proving the chain of evidence from outbreaks in general and particularly where eggs are suspected.
- Through our work we have provided OzFoodNet with questions for use in investigations and contamination data through the supply continuum (AECL Project SAR-42A) which may assist in the attribution process. Additional considerations that are particularly relevant are the age of eggs implicated (Attachment 3) and the likely impact of cooking on log reduction of *Salmonella* of the suspected food (Section 3.3, Table 6).

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9.2 Cracked Eggs

(Extracted from: Todd E.C.D. (1996) Risk assessment of use of cracked eggs in Canada. International Journal of Food Microbiology 30:125-143.)

3. Risk assessment of cracked eggs

3.1. Hazard identification

Seven microbial agents associated with poultry, egg laying barns, eggs and wash water were evaluated as potential hazards in or on cracked eggs. For the first six, no illnesses have been traced to cracked eggs. The seventh, *Salmonella,* has been the cause of outbreaks associated with this product.

3.1.1. *Bacillus cereus*

B. cereus has been found in egg melange made from cracked or broken eggs, raw and pasteurized liquid whole egg, and bakery products made with liquid whole egg in the United Kingdom (Wood and Waites, 1988). The most likely source of the organism in the melange was contaminated egg shells and cracked eggs.

3.1.2. *Campylobacter*

The organism is frequently carried by poultry (Jacobs-Reitsma *et al*., 1995), and can reach eggs. If eggs are dipped in a culture containing hen feces with 10^7 *C. jejuni*/ml added, and stored at 37°-42°C for 10 min. and then at 4°C for 24-48 h, the organisms will reach both the inner and outer membranes and even the contents of some of these eggs (Doyle, 1984; Chaudhary *et al*., 1989). As the eggs cool at 4°C the organisms are drawn through the shell. Cracked eggs are easily penetrated by *C. jejuni* (Chaudhary *et al*., 1989).

3.1.3. *E. coli* O157:H7 and other verotoxigenic *E. coli* (VTEC)

Although colonization of chick intestinal tracts is possible experimentally with *E. coli* O157:H7 (Beery *et al*., 1985), surveys of pasteurized egg fluid and chicken carcasses in Ontario, Canada, have not revealed the presence of any VTEC (Clarke *et al*., 1992).

3.1.4. *Listeria* spp

Listeria innocua has been found in egg wash water in Canada (Laird *et al*., 1991; Farber *et al*., 1992) and *L. monocytogenes* can survive in normal wash water if it is artificially introduced (Laird *et al*., 1991). Egg contents are less likely to be contaminated; *L. monocytogenes* was present in 2 of 42 samples of commercially broken raw liquid egg in the United States (Leasor and Foegeding, 1989), but none of 50 composite whole egg samples in Canada (Farber *et al*., 1992). Once *L. monocytogenes* reaches the yolk, however, as in a cracked or broken egg, it will grow even at 5°C over several days, e.g. 10^5 to 10^8/g in 22 days (Sionkowski and Shelef, 1990).

3.1.5. *Staphylococcus aureus*

In a Japanese study by Suzuki *et al*. (1981), cracked, broken or dirty eggs stored for a long time without washing or disinfecting were contaminated both with *Salmonella* and *S. aureus.* Pasteurization of the melange reduced, but did not eliminate, the organisms. The origin of the *S. aureus* was not determined but presumably came from the farm. Minor and Marth (1976) report that *S. aureus* can originate both from poultry and human sources, but they will not grow in eggs stored at …7.2°C for 12h or less. *S. aureus* has caused intoxications in Canada from boiled eggs but these were hard boiled, decorated and stored at room temperature for more than 1 day (Todd, 1991). A similar problem occurred in Sweden when 46 cases (4 fatalities) resulted from consumption of improperly stored hard boiled eggs (Aronsson *et al*., 1991).

3.1.6. *Yersinia enterocolitica*

Experiments have shown that *Yersinia enterocolitica* can penetrate the shell and membranes over a period of time similar to *Salmonella.* The presence of iron (20 ppm) increased the percentage of eggs spoiled (Amin and Draughon, 1990). Storage of eggs at 10°C however, will not prevent the growth of organisms (counts reached 10^{6-7}/g in 21-28 days at 10°C). Even after 7 days at 10°C with no iron supplementation 14% of eggs were contaminated. *Y. enterocolitica* also grows in egg wash water (Southam *et al*., 1987). If small traces of iron are present in wash water, the risks of *Y. enterocolitica* contamination of egg contents is greater and no signs of infection can be noticed in these eggs (Amin and Draughon, 1990). The contents of cracked eggs would be at even greater risk of contamination.

3.1.7. *Salmonella*

Salmonella is present in the environment and on birds in egg laying barns, and surfaces of eggs can be contaminated from feces or litter. In studies of three United States laying operations, salmonellae were isolated from 30-72% of environmental samples, e.g. water, ventilation fan, egg belt and egg collectors (Jones *et al*., 1995). In an examination of 300 Canadian layer flocks, Poppe *et al*. (1991) found *Salmonella* in environmental samples associated with 53% of the flocks. In addition, 7 of 90 eggshells (7.8%) before washing contained *Salmonella* (Jones *et al*., 1995). This is within the range of 6.3-9.5% contamination of eggshells found when three serotypes of *Salmonella* were administered orally to laying hens (Cox *et al*., 1973).

9.3 Antimicrobial Resistance

Significant international interest, publicity and debate have occurred over the past ten years on the use of antimicrobials in food animals. It is now well accepted by all sides in the debate that the use of antimicrobials in food animals can select for bacteria that are resistant to antimicrobials. These can be antimicrobials that are used in humans, or closely related animal antimicrobials. The resistant bacteria or their resistance genes can be transferred via the food chain to humans where they have the potential to compromise antimicrobial therapy. The controversy revolves around the extent to which this resistance develops, the extent of the spread to humans, and, when it has spread to humans, the extent of the harm (or potential harm) it causes to human health (Turnidge 2003, Phillips *et al* 2003; Wegener, 2003).

In Australia, the Joint Expert Technical Committee on Antimicrobial Resistance comprehensively reviewed all aspects of the subject in its report to the Australian Government (JETACAR Report 1999). The report outlined an antimicrobial resistance management program that focused simultaneously on human and animal use of antimicrobials in Australia. In August 2000, the Australian Government supported the intent of the report and released a public document further elaborating the mechanisms for implementing the JETACAR recommendations (Anon 2000). Further, international agencies (WHO 1997, 2001, 2002; FAO/OIE/WHO 2003, 2004) and governments around the globe and international agencies have produced an array of reports addressing the subject of antimicrobial resistance in the food chain (DANMAP 2002; NORM 2001; SVARM 2002). Consequently, this document repeats only what is necessary to define the context of the problem and nature of the risks in the Australian egg industry.

Hazard identification

Resistance genes

Poultry can harbour bacteria that are usually harmless for humans or other animals (i.e. commensals) but which carry genes encoding for resistance to antimicrobials. These genes are regarded as a potential hazard in food because they may possibly be transferred to human pathogens (by the process of bacterial conjugation) at a later point in time (Obrien 2002). The extent to which this transfer takes place and causes disease has not been firmly established (Swartz 2002) and is one of the key sources of uncertainty affecting the risk-management of antimicrobial resistance in the food-animal industry.

Commensal bacteria

While the gut of poultry harbour many different bacteria only a small proportion of genera have been studied with respect to the occurrence of antimicrobial resistance. Of the commensal organisms, *Escherichia coli* (*E. coli*) and *Enterococcus* spp. isolated from disease-free animals are usually studied from the viewpoint of food safety. These organisms are regarded as good 'indicators' of resistance amongst gram-negative and gram-positive bacteria respectively because they are plentiful in the gut of farm animals, they persist in or on most raw food products, and because they respond to the selective pressures of antimicrobials. Some *E. coli* and *Enterococcus* spp. can be pathogenic for humans in certain circumstances but in the usual processes of testing for resistance these bacteria cannot be distinguished from commensals.

Bacterial pathogens

Bacterial genera that are often associated with disease in humans such as *Staphylococcus*, *Pseudomonas* and *Campylobacter* can occur in poultry and poultry products and are often associated with antimicrobial resistance in human clinical settings. *Staphylococcus* and *Pseudomonas* are infrequently if ever studied in the context of resistance in poultry and poultry products and are not considered in further detail.

Campylobacter spp. are the most commonly reported cause of bacterial gastroenteritis in humans in Australia with a national rate of reported cases in the region of 113-125 cases per 100,000 population (OzFoodNet 2003). The reservoir for *Campylobacter* is the gut of warm-blooded animals, including poultry. In the latter case, transmission to humans is most frequently associated with poultry meat as vertical transmission of *Campylobacter* through the egg is probably a rare event and *Campylobacter* cannot multiply or survive long on the eggshell (Sahin 2003). This is discussed in greater detail in Section 3.1 and Attachment 9.2.

Salmonella is a common animal and human pathogen occurring in poultry populations that may express resistance. *Salmonella* Enteritidis (SE) is a significant cause of human food poisoning in North America, Europe and Asia (Patrick *et al* 2004). The primary source of SE infection for humans is the consumption of contaminated eggs. Resistance of SE to one or more antimicrobials can compromise human therapy. The Australian egg industry is presently thought to be free of SE based on low isolation rates and lack of association between SE in humans and Australian poultry products. This is discussed along with the other aspects of this organism in Section 3.1 and AECL Project SAR-42A.

Bacteria that develop resistance to more than one antimicrobial agent (multiple resistance) are of greater concern than those expressing resistance to only one drug (single resistance). Similarly, preventing the emergence of resistance to drugs that have a critical role in human medicine (eg. vancomycin) is regarded as a very high priority for risk managers of this issue.

Exposure Assessment

Exposure of poultry

Selection pathway

This mechanism of exposure occurs when poultry are treated with an antimicrobial agent, which then imposes a selection pressure on the gut microflora thus encouraging the emergence of genes coding for resistance. With repeated use of antimicrobials the proportion of organisms expressing resistance is increased. The manner in which antimicrobials are used (dose rates, route of administration, frequency of administration, characteristics of the drug preparation etc.) affect the rate of selection for resistance (Shojaee Ali-Abadi *et al* 2000).

Cross contamination pathway

This method of exposure occurs when laying poultry or eggs contact any source of infection or contamination harbouring resistant organisms. This includes other animals (including wildlife and humans), water, feedstuffs, fittings, liquid or solid manures and human effluent. Opportunity for cross contamination is enhanced by the ability of *E. coli* and *Enterococci* spp. to easily survive in the farm environment and to multiply outside of the host. The relative importance of these pathways has not been well studied (ASM 1999).

Assessment

A surrogate method of assessing the magnitude of exposure of livestock to resistant organisms is based on analysis of the pattern of usage of various antimicrobials in the industry concerned (DANMAP 2002, Stege *et al* 2003). When interpreting this information, practices such as frequent use of antimicrobials or any use of a member of a family of drugs that is of therapeutic importance in humans (eg. avoparcin use in livestock in relation to vancomycin use in humans), are interpreted as a warning of the development of resistance in the bacterial flora of the livestock.

JETACAR (1999) reviewed the information available for antimicrobial usage in Australia (animals and humans). While it is possible to describe the volume of each type of drug imported into Australia, there is little information on the volume and frequency of use of each drug in each livestock species, let alone in laying birds. However, the poultry industry is probably in a better position than others to

be able to compile such data because of the relatively small numbers of veterinarians, feed mills and large producers involved in the industry.

The more direct method of assessing the exposure of livestock to resistant organisms is to test the bacterial flora derived from livestock for antimicrobial resistance. Various 'active' (planned and structured surveys of the microbial population) and 'passive' (reliant on pre-existing data-gathering systems such as reports from clinics and diagnostic laboratories) surveillance systems are in place abroad (DANMAP 2002, SVARM 2002, NORM 2001). However, sampling and testing of poultry in these programs is restricted to broilers and broiler meat. No routine surveillance is reported for antimicrobial resistance in bacteria isolated from eggs.

Australia's surveillance system for antimicrobial resistance and antimicrobial usage in livestock is in the process of development, as at September 2004. There are no plans to date to include in the program testing of bacterial isolates from eggs for resistance.

Exposure of product

Eggs are exposed to antimicrobial resistant bacteria in the same way they are exposed to *Enterococcus, E. coli* and *Salmonella.* In the absence of significant vertical transmission of pathogens or commensals via the egg in Australia, the pathway of greatest interest in this review is the external contamination of the eggshell derived from the gut and laying environment. As in the case of many other hazards, cross contamination between products e.g. egg shell contamination of unpasteurised egg pulp, between products and the processing environment, and between products and humans are all pathways that may be important in specific circumstances. The dry eggshell is not an environment that favours the survival of commensal and pathogenic bacteria. The longer the storage time, the lower the survivability of bacteria (and resistant bacteria) on the eggshell.

Exposure of humans

Consumption of undercooked food and cross-contamination in the food preparation area are only two of many possible means by which humans can be exposed to antimicrobial resistant organisms. Further, amongst all the different classes of foods there is likely to be substantial variation in the distribution of antimicrobial resistant organisms and resistance phenotypes. Animal products from those management systems in which antimicrobials are used with greatest frequency are the foods of most concern. A number of other non-food pathways such as environmental contamination are of importance to livestock industries and public health (Obrien 2002) but are not within the context of this review.

Human exposure to resistant bacteria in eggs or egg products is most likely to occur as a result of poor hygiene, cross-contamination from the eggshell or from unpasteurised egg pulp.

Hazard Characterisation

Substantial uncertainty surrounds the health impact arising from ingestion of commensal bacteria that possess resistance determinants. Much of this can be attributed to biological complexity arising from the large variety of commensal bacteria, large number and unknown nature of the mobile elements coding for resistance, ignorance about the mechanisms and conditions under which resistance is transferred to pathogens, and potentially large temporal separation between exposure and the onset of health impacts. Further, there are many other pathways by which humans may be exposed to resistant bacteria besides consumption of food. The existence of many pathways creates much confusion about the extent to which any one pathway may be responsible for adverse human health outcomes arising from antimicrobial resistance.

The evidence for and against a causal relationship existing between the ingestion of resistant organisms and emergence of resistant pathogens in humans has been comprehensively addressed (JETACAR 1999,Turnidge 2003, Phillips *et al* 2003; Wegener, 2003).

Current Controls and Monitoring

The most effective means of controlling the occurrence of antimicrobial resistant bacteria in or on eggs is to minimise the use of these drugs in poultry production. In Australia, there are a number of interlinked factors that minimise antimicrobial use in laying poultry.

- There are a limited number of antimicrobials registered for use in poultry in Australia and even fewer can be used in egg layers, either during rearing or in lay (Table 9.3.1). Chlortetracycline, spectinomycin, lincomycin and flavophospholipol are registered for use in both rearing and lay, while bacitracin and neomycin can be used only in rearing of layer birds.
- Recent harmonisation of legislation in States and Territories has limited the off-label use of antimicrobials in food animals. A veterinarian can only prescribe an antimicrobial 'off-label' if it is registered in another major food-producing species. Non-veterinarians cannot authorise 'off-label' use. In addition specific label restraints on some products preclude off-label use altogether. e.g. "DO NOT USE in/on birds which are producing eggs or may in the future produce egg or egg products for human consumption",
- The inclusion by the National Drugs and Poisons Schedule Committee of all antimicrobials for use in the poultry industry (other than flavophospholipol, avilamycin, roxarsone and the ionophore coccidiostats) in Schedule 4 (restricted to supply by prescription only). The non-S4 antimicrobials are not used in human medicine.
- There is minimal use of antimicrobials for 'growth promotion' purposes. The only antimicrobial registered for this purpose in laying hens is flavophospholipol. Despite the fact that this class of antimicrobial is not used in humans, and therefore resistance to this product has no public health implications, it is not widely used (due to cost and the industry does not want to use 'growth promotants').
- The development and adoption by the Australian Poultry Veterinary Association of a Code of Practice for the Use of Antibiotics in the Poultry Industry (2001). The Code contains guidelines for the prudent use of antimicrobials.
- The increasing availability and use of vaccines to control infectious diseases that were formerly controlled by antimicrobial prophylaxis.

Illegal and clandestine use of unregistered antimicrobials is recognised as a problem in livestock production abroad (especially Europe) but is not thought to be significant in the Australian poultry industry. This is in part due to the progressive implementation of uniform 'Control of Use' legislation in States and Territories that sets clear parameters for the use of antimicrobials in food animals. Another factor contributing to responsible antimicrobial use in the Australian poultry industry factor is the development and adoption by the Australian Veterinary Poultry Association of a Code of Practice for the Use of Antibiotics in the Poultry Industry (2001). The Code contains guidelines for the prudent use of antimicrobials. More recently, in accordance with JETACAR Recommendation 6, many antibiotics used in the poultry industry have been rescheduled as S4 medications which must be prescribed by a veterinarian.

There is a paucity of Australian data on antimicrobial resistance in bacterial isolates from eggs and laying hens and the extent of the potential transfer of resistance (if any) originating in the egg industry is unknown.

Trade Perspective

Freedom from *Salmonella* Enteritidis is estimated to have a Net Present Value to Australia of $965 million over 20 years (Sergeant *et al* 2003). Any national program that has its aim to maintain this desirable status is likely to have a surveillance component to it that is focussed on detecting the presence of SE. Systematic testing for antimicrobial resistance of bacterial isolates collected under

this program can provide the egg industry with objective data on the antimicrobial resistance status of isolates derived from layer enterprises.`

Recommendations

- The Australian egg industry would be advised to keep itself informed of technical developments in the study of the association between antimicrobial use in livestock and antimicrobial resistance in human pathogens since this is an overriding source of uncertainty that dominates the decision options available to risk managers.
- Risk management decisions on antimicrobial resistance should account for the fact that it is not just a food safety issue but also one that impacts on the efficiency and economics of animal production and on the indirect transmission of resistance through environmental pathways.
- The egg industry should be made aware that it has a potential competitive advantage (compared to other food products and meat products) with respect to the low probability of occurrence of resistant bacteria in eggs.
- The Australian egg industry should consider whether or not a pro-active attempt to demonstrate the antimicrobial resistance status of layer birds and eggs could be of benefit to domestic and international trade. The egg industry may be able to readily ascertain the resistance status of bacteria originating in the egg industry if resistance testing was an add-on to other surveillance programs for pathogens or commensals.
- The egg industry can work with the Australian Veterinary Poultry Association to collate objective antimicrobial use data in the industry (while respecting commercial sensitivities) that will help inform decisions of risk managers.
- National data on the antimicrobial resistance profile of *Salmonella* isolates could become available if the national SE surveillance program is implemented.

Table 9.3.1: Antimicrobial classes and antimicrobials used in poultry in Australia

[Adapted from a table by Dr Mary Barton (University of SA, pers comm.)]

Antibiotic class	Poultry
Aminoglycosides	
Apramycin	+[1]
Gentamicin	#
Neomycin	+[1]
Spectinomycin	+
Amphenicols	
Chloramphenicol	#
Orthosomycins	
Avilamycin	✖[2]
Cephalosporins	-
Bambermycins	
Flavophospholipol	✖
Fluoroquinolones	#
Glycopeptides	✻
Lincosamides	
Lincomycin	+
Macrolides	
Erythromycin	+[2]
Spiramycin	+[4]
Tylosin	+[2]
Arsenicals	
3-nitro-arsonic acid	+[2]
Nitrofurans	#
Nitroimidazoles	
Dimetridazole	+[2]
Metronidazole	#
Penicillins	
Ampicillin/amoxycillin	+[5]
Pleuromutilins	
Tiamulin	+[2]
Polyethers (Ionophores)	✧
Polypeptides	
Bacitracin	✖
Quinoxalines	-
Rifamycins	-
Streptogramins	
virginiamycin	+[3]
Sulphonamides (including trimethoprim & diaveridine)	+[5]
Tetracyclines	
Chlortetracycline	+
Oxytetracycline	+[2]

Legend:

\# use of these products is specifically prohibited in food producing animals

✖ registered for use as a growth promotant - no related human antibiotics; bacitracin and avilamycin also have claims

✻ avoparcin has not been registered since mid-2000 and no other glycopeptides are registered for use in animals

✧ registered as coccidiostats in broiler and layer chickens - no related human antibiotics

1 registered for use in non-laying chickens

2 cannot be used in poultry, which are producing or may in the future produce eggs for human consumption

3 under review by the APVMA – draft recommendation to discontinue current registration as a growth promotant but allow prophylactic use in poultry;

4 one spiramycin product is registered in poultry with no label restraint; however, advice is that it is not used in the poultry industry.

5 permitted for use in non-laying chickens

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9.4 Plant-Associated Toxins

Hazard Identification

Plant-associated toxins (PATs) are naturally occurring chemicals, widely varying in chemical structure and bioactivity, that are:

- Phytochemicals, produced by plants i.e., plant secondary metabolites, not directly related to nutritional requirements of the plants but probably evolved as defences against herbivory
- Bacterial secondary metabolites produced by bacteria growing in or on plants
- Mycotoxins produced by saprophytic or endophytic fungi growing on or within living or dead plants. The fungal growths can occur in the field or in storage of fodder and grains.

The occurrence of plants capable of poisoning livestock is widespread (Everist, 1974). There is an abundance of literature on acute and chronic adverse effects of PATs on animals. For example, a recent review (Allen *et al*., 2002) described several plant-associated toxin diseases of livestock that have occurred for the first time in Western Australia alone over the past 10 years. Many investigations clearly show the adverse effect on chicken health and productivity but little is known about the potential for the toxins to be translocated to eggs for human consumption. There are also literature reports on the poisoning of humans *via* toxins intrinsic to the foods we eat or to contaminants of the food we eat (Colegate *et al*., 1998 and refs therein).

Whilst many PATs have been isolated and identified as the causative agents of toxicity, many plants capable of inducing a toxic effect have not been investigated to the extent that these causative agents, or other causative factors, have been identified.

In many instances where the causative agents and/or factors have been identified, the mechanism of action of the toxins or the pathogenesis of the ensuing disease have not been fully elucidated. Adverse effects can be acute through to chronic and affect all systems within the body. It is the more chronic effects that are difficult to attribute to plant sources and thus may form the basis of non-tariff trade barriers if trading partners or consumers opt for a precautionary approach to PAT-related food safety issues. Questions related to the bioavailability of PATs to human consumers, their acute effects and their chronic effects due to long term, low level exposures, would be expected if chickens were known to be exposed to the PATs.

PATs are potential hazards and a potential risk to trade access.

Exposure Assessment

Exposure of chickens

Chickens are exposed to PATs *via* contaminated feed. Supplied feed can present a particular problem if the PATs are concentrated in the fines or lower quality grains as a result of any cleaning process. Stored feed can also become toxic if conditions allow the development of toxigenic bacteria or fungi.

Exposure of product

Eggs can only be contaminated with PATs if the laying chicken has ingested the PATs. The extent of translocation to the egg depends upon the physical and chemical properties of the toxins that govern the overall toxicokinetics and dynamics of the specific PATs.

Exposure of humans

Humans can be exposed to PATs in a primary or secondary manner.

Since PAT-containing plants are common weeds in grain crops, humans can be exposed, in a primary manner, to PATs by inhalation of dust associated with grain harvesting, transportation and processing,

or by ingestion of food products from contaminated grain, especially when a local, contaminated crop is sourced by the consumer for home processing.

If an animal is primarily exposed to PATs, then humans could be exposed in a secondary manner if the food products derived from the exposed animal are contaminated and ingested.

Information on the distribution of PATs and/or their metabolites within animal tissues is required.

Hazard Characterisation

The potential contamination of poultry eggs with PATs is associated with contamination of chicken feed stock derived from cultivated grains or crops. The extent of contamination will depend upon the quality of the feedstock and the stability of the PATs during any processing (eg to make pellets) or storage. Using lower grade "seconds" can be particularly hazardous if PATs are concentrated during the cleaning processes or if the quality has been downgraded due to higher than acceptable weed contamination or fungal infection.

PATs vary in chemical structure, bioavailability, toxicodynamics and toxicokinetics, and the effects (clinical, pathological, biochemical) on the whole animal and individual organs.

The hazard presented by specific PATs requires formal assessment on a case-by-case basis.

Current Controls and Monitoring

There are very few current formal controls or monitoring for PAT contamination of poultry eggs and products. Some levels of mycotoxins that are acceptable in food include 20ppb aflatoxins and 5ppb for phomopsins and zearalenone.

The Food Standards Australia New Zealand (FSANZ), formerly Australia New Zealand Food Authority (ANZFA), commissioned a review of the potential for some PATs to enter the human food supply and the consequent effects that might be expected. The report forms part of Proposal P158 – Review of the maximum permitted concentrations of non-metals in food (April 1999) (ANZFA, 1999). This review made no recommendations specific to poultry egg-derived food for the human food supply.

Potential Control Options

The best control option is to avoid exposure of layer chickens to the PATs. Carefully monitored feed supplies would help ensure that contaminated grain or processed feed are not offered to the chickens.

Trade Perspectives

At this stage, with a lack of knowledge on the transfer of PATs or their metabolites to eggs, and the subsequent availability of these to consumers of the eggs, the main issue from a trade perspective is related to perception.

If it is perceived that poultry eggs and resultant products are being derived from hens potentially fed with PAT-contaminated feed then consumers, trading partners and public health watchdogs could be expected to ask questions about the human health safety of the eggs and other products that use eggs.

The paucity of both toxicological and dietary exposure data on natural toxins limits the ability of Codex or individual countries, including Australia, to set scientifically-based food standards for these substances. The lack of monitoring data on the levels of natural toxins in foods also makes it difficult to determine the levels of toxin which are 'reasonably achievable' through good agricultural practice. Internationally, the safe level of exposure (the so-called 'provisional tolerable daily (or weekly) intake') is established by FAO/WHO, but this can only be undertaken where adequate toxicological

data is available. In its recent review of non-metal contaminants, ANZFA (1999) reviewed the available data on 18 substances for which there were already standards or for which there were safety concerns, nationally or internationally. No standards were recommended for Fusarium toxins, ochratoxins or pyrrolizidine alkaloids (PA's), due to the inadequacy of toxicity and dietary intake data.

Recommendations

Toxicokinetic and toxicodynamic studies should be undertaken to accurately determine the distribution and accumulation of specific PATs and their metabolites to eggs. This will determine whether there is any need for concern over potential contamination of poultry eggs with PATs or their metabolites.

A program of monitoring feed and certification of freedom from specific PATs will assist producers to ensure clean feed.

Specific PAT analytical methods should be optimised and validated for use with poultry eggs to provide a monitoring capability in the event that toxicokinetic studies indicate cause for concern. These analytical procedures will also provide the means for certification to customers on the PAT status of eggs if required.

If specific PATs or their metabolites are shown to be potential, bioavailable contaminants of poultry eggs then maximum tolerable levels for various exposure time periods need to be established. These will result from determinations of toxicological No Observed Effect Levels and the identification of specific biomarkers of human exposure for orally ingested PATs.

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Specific Examples of Importance to the Australian Poultry Egg Industry

Corynetoxins

Hazard Identification

Corynetoxins (CTs) are a family of tunicamyluracil-glycolipids produced by a bacterium (*Rathayibacter toxicus*) that colonizes nematode (*Anguina* spp.) galls in the seed-heads of various grasses (Edgar *et al*., 1982). The CTs cause Annual Ryegrass Toxicity (ARGT), Stewart's Range Syndrome and Floodplain staggers when the bacterium/nematode complex is associated with *Lolium rigidum* (annual ryegrass), *Polypogon monspeliensis* (annual beardgrass) and *Agrostis avenacea* (blowngrass), respectively (Bryden *et al*., 1994).

ARGT is a major animal health problem in Western Australia and South Australia with in excess of 90,000 sheep fatally affected in bad seasons in Western Australia alone. In usual seasons 20,000 – 30,000 sheep can be fatally affected in Western Australia. The disease occurs mainly in the early summer months when the annual ryegrass starts to senesce and the bacterium starts to produce toxins.

The CTs are potent, irreversible, transition state analogue inhibitors of *N*-acetylglucosamine-1-phosphate transferase (GPT). Since this enzyme catalyses the initial step in the biosynthesis of the dolichol-linked oligosaccharide chains destined for *N*-linking to proteins, the CTs block N-linked glycoprotein synthesis (Jago *et al*., 1983) and consequently have high, general mammalian toxicity. A lethal oral dose of corynetoxins for sheep, cattle or pigs is between 1 and 3.5 mg/kg bodyweight but no research has yet been completed on the toxic effect on chickens.

Whilst the effects of large doses of CTs have been well described (Jago and Culvenor, 1987), the effects of long term, low level exposure to these toxins in the diet or environment are unknown. However, because the CTs appear to be cumulative in their action there is reason to suspect this type of exposure may pose a risk to human and animal health (Colegate *et al*., 1998).

The Standing Committee on Agriculture and Resource Management (SCARM) Council of Australia and New Zealand has addressed this issue. In 1997 it formed a Working Group to assess the problem associated with corynetoxins in agricultural produce. The Working Group has prepared a through chain HACCP based risk management plan for natural toxins in human foods and animal feedstuffs in the supply chain (unpublished).

Corynetoxins are potential hazards and a potential risk to trade access.

There is a potential for the corynetoxins to contaminate grain intended for livestock consumption. Poisonous annual ryegrass commonly occurs as a weed in wheat and barley crops and grain cleaning is sometimes necessary to lower annual ryegrass seed contamination to levels which conform with grain receival specifications. The crop residues generated this way are potentially quite poisonous. Some seeds and dust containing corynetoxins may also remain in the cleaned portion of the grain. The increasing resistance of annual ryegrass to herbicides is likely to exacerbate the problem. However, information relating to the levels of corynetoxin in grain intended for human consumption is not yet available. The recognition that *R.. toxicus* can now colonise at least three grass types raises questions about the potential of this bacterium to further extend its host range (ANZFA 1997).

Exposure Assessment

Exposure of layer hens
All layer hens can be exposed to corynetoxins in their feed supply.

The major areas of exposure of livestock to contaminated feed are in the southern regions of Western Australia and South Australia where Annual Ryegrass Toxicity is endemic. This will be exacerbated by any tendency for the producer to acquire cheaper, second grade feed or screening fines. However, exposure *via* grain and processed feed depends on the source of the feed and can therefore occur anywhere to which contaminated feed is transported.

Corynetoxins, extracts of toxic seedheads and toxic ryegrass that may contaminate feedgrains, have been found to be lethal to all animal species tested, including sheep, cattle, horses, pigs, guinea pigs, rats, mice and chickens (ANZFA, 1997). Exposure of humans to corynetoxins or to tunicamycins has not been found in the published literature, but given its mechanism of action and its lethality in all animal species tested, it would seem reasonable to assume that humans are no different to other animals in susceptibility.

Exposure of humans
Within the poultry egg industry, handlers of contaminated feed may be exposed to corynetoxins in the dust generated. Exposure *via* ingestion of eggs will depend upon the amount translocated and stored in the egg, and the amount of eggs ingested. This also applies to the use of eggs in making of other food products.

Hazard Characterisation

There have been no instances of human clinical symptoms being ascribed to exposure to corynetoxins. The corynetoxins have an affinity for cellular membranes and have an unquantified cumulative action. The clinical and sub-clinical effects of long term, low level exposure to the cumulative corynetoxins are unknown but would, in all likelihood, not be attributed to CT-intoxication by examining physicians at this stage.

Conceivably there may be potential for accumulation of CTs and their effects, during long-term, low level exposure, until an adverse threshold is reached and clinical effects are manifested. Given the mode of action of the CTs i.e., inhibition of protein N-glycosylation, there could be a broad spectrum of clinical effects that may not be easily attributable to CT-intoxication.

Current Controls and Monitoring

There are no current formal controls or monitoring for CT contamination of poultry eggs or the products made using poultry eggs.

An enzyme-linked immunosorbent assay (ELISA) for the presence of CTs in grains and fodder has been developed. This would need to be tested, validated and optimised for use in poultry eggs before it could be applied as a routine, formal testing procedure for CT contamination. ANZFA (1999) did not make any recommendations regarding acceptable levels of corynetoxins in the diet due to insufficient scientific data (Colegate, pers comm).

Potential Control Options

The best control option is to avoid exposure of layer hens to feed grain contaminated with infected annual ryegrass, annual beardgrass and blown grass (or any other grasses that may become involved in the aetiology of this disease). Carefully monitored feed supplies would help ensure that contaminated grain or grain products are not offered to the hens. Producers would need to carefully consider sourcing of their hen feed, especially downgraded grains bought directly from grain producers.

Trade Perspectives

At this stage, with a lack of knowledge on the transfer and bioaccumulation of CTs in eggs, and the subsequent availability of any stored CTs to consumers of the eggs, the main issue from a trade perspective is related to perception. If it is perceived that eggs are being derived from CT-exposed

hens then consumers, trading partners and public health watchdogs could be expected to ask questions about the human health safety of the product.

Recommendations

Pharmacokinetic and pharmacodynamic studies should be undertaken to accurately determine the rate of distribution and accumulation of corynetoxins in eggs. This will determine whether there is any need for concern over potential contamination of eggs with CTs.

The corynetoxin ELISA should be optimised and validated for use with eggs to provide a monitoring capability in the event that pharmacokinetic studies indicate cause for concern. This will also provide certification to customers on the CT status of products.

If corynetoxins are shown to be potential, bioavailable contaminants of poultry eggs then maximum tolerable levels for various exposure time periods need to be established. These will result from a determination of a No Observed Effect Level, and specific biomarkers of exposure for corynetoxins in the diet.

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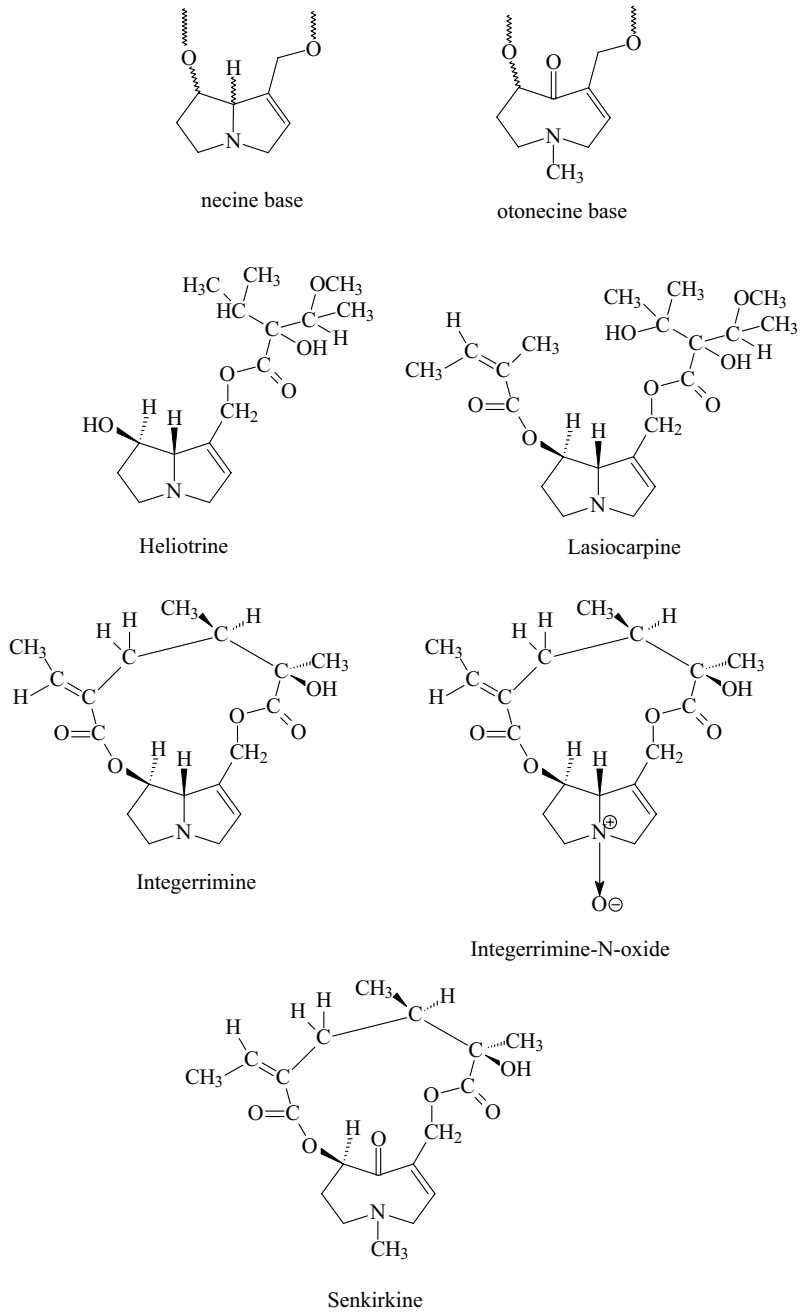
Pyrrolizidine Alkaloids

Hazard Identification

Pyrrolizidine alkaloids (PAs) are naturally occurring chemicals that can be found in some plant species. The hepatotoxic PAs (over 350 have been identified from over 6000 plant species) are mono, di or macrocylic di esters of the unsaturated necine or otonecine bases (see Figure 9.4.1). The PAs also occur as their respective N-oxides that are more water-soluble but can still be toxic following *in vivo* reduction back to the parent PA after ingestion.

Fig. 9.4.1 Some representative pyrrolizidine alkaloid structures



Pyrrolizidine alkaloids are not toxic *per se* but are metabolically activated in the liver giving rise to highly reactive, toxic pyrrolic molecules.

PA-containing plants can be primary sources of PAs for grazing animals or for humans that ingest those plants (Stegelmeier *et al*., 1999 and refs therein). Poisoning of humans by PAs, either as natural components of herbal preparations or as contaminants in bread, has been well documented (Colegate *et al*., 1998 and refs therein). In addition PAs can be transferred into the meat offal and milk of animals grazing PA-containing plants, into the eggs of poultry supplied with contaminated feed and into honey produced by bees that forage on those plants (ANZFA, 1999; Colegate *et al*., 1998 and refs therein; Edgar and Smith, 2000).

The toxic PA metabolites, the "pyrroles", can bind to DNA and enzyme and structural proteins (Prakash *et al*., 1999 and refs therein). Thus, in addition to being liver toxins, the PAs are potential carcinogens and genotoxins.

The major reported clinical symptoms of PA intoxication in humans result from a veno-occlusive disease of the liver. However, other effects of long term, low level exposure to PAs *via* the diet (grain, eggs, milk, meat, honey, and related products) are unknown. Consequently, statutory and draft regulations or recommendations exist in some European Countries, Australia and South Africa which limit or ban the presence of PAs, and their N-oxides in herbal products and food (Table 9.4.1).

Table 9.4.1: Examples of regulations for PAs and their N-oxides

Country	Acceptable Level	Comments
Australia	1 microgram/kg BW* /day	Provisional ANZFA (FSANZ) tolerable level based on veno-occlusive disease in humans
Austria	Nil tolerance	In herbal preparations. Unsure of legal status
Netherlands	0.1 microgram/ 100g of food	Applies to all food. Unsure of legal status or any time restrictions for multiple ingestion of contaminated food
Germany	0.1 micrograms/day or 1 ug/ day for a maximum of 6 weeks. Nil for pregnant and lactating women, and children	Applies to herbal preparations. Based on the potential for genotoxic carcinogenicity. No rational reason not to extend to include foods.

* BW = body weight

Recent work (Williams *et al*., 2002 and refs therein) has confirmed both the carcinogenicity of riddelliine in rats and the toxicity of the N-oxide. Confirmation of toxicity of the N-oxide (albeit *via* metabolic reduction and activation), previously considered to be non-toxic metabolites of PAs, has significance in that the PAs are present in plants predominantly as the N-oxides.

The Food Standards Australia New Zealand (FSANZ), formerly Australia New Zealand Food Authority (ANZFA), commissioned a review of the potential for PAs to enter the human food supply and the consequent effects that might be expected. The report forms part of Proposal P158 – Review of the maximum permitted concentrations of non-metals in food (ANZFA 1999). Contrary to considerations, and consequent regulations, internationally the FSANZ report considers veno-occlusive disease, and not genotoxicity or carcinogenicity, as the toxicity-defining event for humans.

PAs are a foodborne hazard with a potential risk to trade access. The proportional contribution to daily intake in humans is unknown.

Exposure Assessment

Exposure of layer hens
In Australia, layer hens can be exposed to PAs *via* grains and prepared animal feeds. The main PA-containing plants include *Echium plantagineum*, *E. vulgare*, *Heliotropium europaeum*, *H. ovalifolium*, *Senecio jacobaea*, *S. lautus*, *S. madagascariensis*, *Crotalaria retusa*, *C. crispata*, *C. pallida*, *Amsinkia intermedia*, and *Trichodesma zeylanicum*.

Downgraded grain or grain screenings, in which PAs and their N-oxides could be concentrated, and processed layer hen feed manufactured with contaminated ingredients form the major pathways of exposure.

Exposure of humans
Humans can be exposed to PAs in a primary or secondary manner.

Since PA-containing plants are common weeds in grain crops, humans can be exposed, in a primary manner, to PAs by inhalation of dust associated with grain harvesting, transportation and processing.

Once ingested by the layer hen, the PAs can be transferred to eggs and therefore can present a risk to human consumers.

Hazard Characterisation

The potential contamination of poultry eggs for human consumption is a product of the initial contamination of the feed, the rate or extent of translocation of absorbed PAs or their N-oxides into the eggs, and the subsequent bioavailability of those translocated PAs for human consumers of the eggs. An illustrative example is a problem that occurred several years ago in Australia when between 100,000 to 200,000 chickens and 1000 to 4000 pigs died from PA poisoning as a result of heliotrope-contaminated stock feed (Gaul *et al*., 1994). Whilst in this case it was evident from the mortality rates that a problem existed, the possible consequences of low level exposure of the animals to the pyrrolizidine alkaloids are harder to define, especially when the PAs can induce a slow, progressing liver failure rather than sudden death (Pass, 1982). This has important implications for human health when eggs from asymptomatic, intoxicated hens are consigned to the human food supply. One literature report (Edgar and Smith, 2000) identifies PAs from *Echium* sp. and *Heliotropium* sp. in eggs at levels that would exceed current regulations in some countries. Another report, looking at the effects of *Senecio vernalis* on laying hens did not identify any transfer of *Senecio* PAs into the eggs (Eroksuz *et al*., 2003).

Current Controls and Monitoring

There are no current formal controls or monitoring for PA contamination of poultry eggs. The main control would seem to be observation of clinical or productivity effects which would be too late to prevent transfer of PAs to the eggs.

An enzyme-linked immunosorbent assay (ELISA) for the presence of PAs in grains and fodder has been developed. This would need to be tested, validated and optimised for use in poultry eggs before it could be applied as a routine, formal testing procedure for PA contamination.

Potential Control Options

The best control option is to avoid exposure of layer hens to the PA-containing plants or plant parts that may contaminate feed products. Carefully monitored feed would help ensure that contaminated feed is not offered to the hens.

Trade Perspectives

At this stage, with a lack of definitive knowledge on the extent of transfer and accumulation of PAs or their metabolites in eggs, and the subsequent availability of these to consumers of the eggs, the main issue from a trade perspective is related to perception.

If it is perceived that eggs are being derived from PA-intoxicated hens then consumers, trading partners and public health watchdogs could be expected to ask questions about the human health safety of the product.

Recommendations

Studies should be undertaken to accurately determine the distribution and accumulation of all the prevalent (in Australia) PAs, their N-oxides and their metabolites to eggs. Following confirmation of transfer to, and accumulation in eggs research will be required to determine whether the accumulated PAs present a real risk to consumers of the eggs.

The PA ELISAs should be optimised and validated for use with eggs to provide a monitoring capability in the event that the translocation studies indicate cause for concern. This will also provide certification to customers on the PA status of eggs.

Since PAs or their metabolites have been shown to be potential contaminants of eggs then maximum tolerable levels for various exposure time periods need to be established. These will result from a determination of No Observed Effect Levels and biomarkers of exposure for the various PAs found in eggs.

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Mycotoxins

Hazard identification

Mycotoxins are naturally occurring chemicals, widely varying in chemical structure and bioactivity that are produced by saprophytic or endophytic fungi growing on or within living or dead plants. Storage conditions for animal feed (fodder, grains) can encourage the growth of fungi and the subsequent production of clinically significant mycotoxins.

The occurrence of mycotoxins capable of poisoning livestock is widespread (Everist, 1974). There is an abundance of literature on acute and chronic adverse effects of mycotoxins on animals. There are also literature reports on the poisoning of humans *via* mycotoxin contaminants in the food supply (D'Mello and MacDonald, 1998).

Fungi producing mycotoxins can be classified broadly into two forms:

- Endophytes: live within living plants eg. *Acremonium (Neotyphodium)* spp., *Claviceps* spp., *Balansia* spp., *Myriogenspora* spp., *Epicloe* spp.
- Saprophytes: live on dead and decaying plant material eg. *Phomopsis (Diaporte)* spp., *Pithomyces* spp.

Mycotoxins can be broadly classified by the clinical or pathological effect that they exert (Table 9.4.2).

Whilst many mycotoxins have been isolated and identified as the causative agents of toxicity, many fungi and plant-fungi interactions capable of inducing a toxic effect have not been investigated to the extent that these causative agents, or other causative factors, have been identified. In many instances where the causative agents and/or factors have been identified, the mechanism of action of the toxins or the pathogenesis of the ensuing disease have not been fully elucidated.

Adverse effects can be acute through to chronic and affect all systems within the body. It is the more chronic effects that are difficult to attribute to mycological sources and thus may form the basis of non-tariff trade barriers if trading partners or consumers opt for a precautionary approach to mycotoxin-related food safety issues.

The potential for accumulation of diet-derived mycotoxins in eggs for humans is generally unknown. Questions related to the bioavailability of specific mycotoxins to human consumers, their acute effects and their chronic effects due to long term, low level exposures, would be expected if layer hens were known to be exposed to the mycotoxins.

Table 9.4.2: Effect classification of mycotoxins found in Australia

Main Effect	Fungal Source	Toxins
Hepatotoxicity	*Penicillium* spp.	Rubratoxins
		Luteoskyrin
		Cyclochlorotine
	Diaporte spp.	Phomopsins
	Aspergillus spp.	Aflatoxins
	Pithomyces spp.	Sporidesmin
Nephrotoxicity	*Penicillium* spp.	Ochratoxins
		Citrinin
Neurotoxicity	*Penicillium* spp	Penitrems
		Lolitrems
		Patulin
		Citreoviridin
	Acremonium spp.	Ergopeptines
		Lolitrems
	Claviceps spp.	Ergopeptines
Oestrogenic Effects	*Fusarium* spp.	Zearalenols
		Zearalenone
Cytotoxicity	*Fusarium* spp.	Tricothecenes
		Nivalenols (eg. DON, Vomitoxin)
		T-2 toxin
		HT2 toxin
Multiple Effects	*Penicillium* spp	Cyclopiazonic acid

Exposure Assessment

Exposure of layer hens

Layer hens will be exposed to mycotoxins in contaminated feed. Supplied feed can present a particular problem if the mycotoxins are concentrated in the fines or lower quality grains as a result of any cleaning process. Inappropriately stored feed can also become toxic, or increase in toxicity if conditions allow the development of toxigenic fungi.

Deoxynivalenol (DON), also known as vomitoxin, is a secondary metabolite of some species of the fungal genus *Fusarium*. It is sometimes a contaminant of wheat grown in many regions throughout the world. Fusarium infections of wheat heads produce the disease known as Fusarium Head Blight (FHB) or Scab and the concomitant production of DON. DON contamination is often at low levels in wheat crops but in some years FHB outbreaks overseas have occurred in durum wheat on the Liverpool Plains in Northern NSW (Southwell *et al.,* 2003). FHB results in yield losses through reduction in the size and number of kernels produced, and the quality of infected kernels is reduced including contamination with DON. DON is not carcinogenic but can cause an emetic response and reduced weight gain, particularly in young animals. The Codex Alimentarius Commission has discontinued work on a draft maximum level for DON for the time being (CAC, 2004). In the U.S.A. the maximum permitted in finished wheat products for human consumption is 1 ppm, and in the European Community a draft limit of 0.5 ppm for cereal products as consumed and other cereal products at the retail stage is proposed, and there is a discussion limit in baby food of 0.1 ppm. Fusarium Head Blight is typically associated with wet weather in periods before, during and following anthesis (flowering) of wheat. In Australia, due to the relatively dry climate in which most wheat is grown, the occurrence of DON in wheat has been rare. The only known significant incidence of contamination occurred in crops in the Southern Liverpool Plains region of North Eastern New South Wales in the 1999 growing season. An outbreak of FHB occurred in the following year in the same region, but flooding destroyed many affected crops.

Aflatoxins (known human liver carcinogens) are usually present at low frequency and concentration in maize grown in temperate regions of Qld and NSW, but occasional samples contain high concentrations. Aflatoxin production by the fungi *Aspergillus flavus* and *A. parasiticus* is favoured by high temperatures, insect attack, premature drying of the ear during filling and persistent high humidity during maturation. Useable information on aflatoxins in the Australian diet comes from three major sources: (i) a data bank from the Australian Government Analytical Laboratories (AGAL) containing 16000 entries from all AGAL laboratories during the period 1992 to 1997; (ii) a data bank from AGAL in New South Wales for 1997 and part of 1998; and (iii) data derived from information gathered for inclusion in the "Australian Mycotoxin Data Centre Newsletter" (AMDC) published by CSIRO Division of Food Science and Technology (now Food Science Australia) since 1983 (ANZFA 1999). After nuts, maize produced in Australia registered the next highest level of contamination. Residues of Aflatoxin B1 in laying hens diets has been demonstrated to be transmitted to eggs at a ratio of feed to eggs of 5000:1 (Bintvihok *et al.,* 2002; Oliveira *et al.,* 2003).

Exposure of product
Eggs can only be contaminated with mycotoxins if the hen has ingested the mycotoxins. The extent of transfer to eggs depends upon the overall toxicokinetics and dynamics of the specific mycotoxins in the hens.

Exposure of humans
If absorbed dietary mycotoxins are transferred to eggs then the resultant exposure of human consumers will depend upon the bioavailability of the stored toxins. This research is required before questions related to food safety can be definitively answered.

Hazard Characterisation

The potential contamination of poultry eggs for human consumption is intricately associated with contamination of feed stock derived from cultivated grains or crops.

Mycotoxins vary in chemical structure, bioavailability, toxicodynamics and toxicokinetics, and the effects (clinical, pathological, biochemical) on the whole animal and individual organs. Toxicities of mycotoxins include carcinogenicity, mutagenicity, genotoxicity, hepatotoxicity, nephrotoxicity and embryotoxicity.

The hazard presented by specific mycotoxins requires formal assessment on a case-by-case basis. For example, it is known that the carcinogenic aflatoxins and ochratoxin A can be transferred to eggs. Some reports have indicated that the *Fusarium* mycotoxins, zearalenone (Daenicke *et al*., 2002) and vomitoxin (deoxynivalenol) present in chicken diets were not detected in eggs but another, more recent report (Sypecka *et al*., 2004) detected deoxynivalenol but not zearalenone. Cyclopiazonic acid has been shown to be transferred to egg white and yolk to levels of 100 and 10 ppb respectively (Dorner *et al*., 1994). The translocation of other mycotoxins remains to be determined.

Current Controls and Monitoring

There are very few formal controls or monitoring for mycotoxin contamination of egg and egg products. In Australia, the Food Standards Code sets maximum levels (MLs) of specified metal and non-metal contaminants, and natural toxicants in nominated food through Standard 1.4.1 – Contaminants and Natural Toxicants (ANZFA 1999).

In the Standard, an ML has only been established where it serves an effective risk management function and only in foods that provide a significant contribution to total dietary exposure. Foods not listed in this Standard may contain low levels of contaminant or natural toxicants, however, MLs have not been assigned to many foods because they present a low public health risk. A review of this hazard forms part of Proposal P158 – Review of the maximum permitted concentrations of non-metals in food (April 1999) (ANZFA, 1999).

Maximum limits have been listed in Standard 1.4.1 - Table to clause 3 – Maximum levels of non-metal contaminants in food - in the FSC for the following mycotoxin/food combinations.

Contaminant – food combination	mg/kg
Aflatoxin	
Peanuts	0.015
Tree nuts (as specified in Schedule 4 to Standard 1.4.2	0.015
Ergot	
Cereal grains	500
Phomopsins	
Lupin seeds and the products of lupin seeds	0.005

Internationally, there is little harmonisation of tolerable limits associated with mycotoxins in food and, as a result, limits set on a national or regional level are generally set to reflect local conditions.

In Australia, the major form of monitoring is restricted to monitoring of overtly 'mouldy' feed or for the demonstration of clinical signs such as the loss of egg production in hens.

Potential Control Options

The best control option is to avoid exposure of layer hens to the mycotoxins. Carefully monitored feed supplies would help ensure that contaminated feed is not offered to the hens.

Trade perspectives

At this stage, with a lack of knowledge on the accumulation of many mycotoxins or their metabolites in eggs, and the subsequent availability of these to consumers of the eggs, the main issue from a trade perspective is related to perception.

If it is perceived that eggs are being derived from hens exposed to dangerous mycotoxins then consumers, trading partners and public health watchdogs could be expected to ask questions about the human health safety of the product.

Recommendations

Analytical studies should be undertaken to accurately determine the distribution and accumulation of specific mycotoxins and their metabolites in the eggs. This will determine whether there is any need for concern over potential contamination of eggs with mycotoxins or their metabolites. This will also provide certification to customers on the mycotoxin status of eggs if required.

If mycotoxins or their metabolites are shown to be potential, bioavailable contaminants of eggs then maximum tolerable levels for various exposure time periods need to be established. These will result from a determination of No Observed Effect Levels and biomarkers of exposure for the various mycotoxins in the diet.

Encouragement should be forthcoming to develop assays that would enable rapid certification of feed to be free of mycotoxins.

While proposals to monitor eggs for mycotoxins would provide valuable information, initial efforts might be better targeted at analysis of feed, as contamination of feed is the Critical Control Point for entry of mycotoxins into eggs.

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Attachment 10

Modifications to Risk Rating Spreadsheet Tool and Sensitivity Analysis

In order to accommodate egg-specific issues into the Risk Ranger approach (Table 10.1), the designer was consulted and the following modifications inserted.

Following a request by stakeholders a sensitivity analysis has been included to enable better appreciation of the relative impact on risk that might result from changes to input values.

Question 6: Probability of Contamination of Raw Product per Serving

The original Risk Ranger values for the probability of contamination of raw product are too large when compared to surveys of *Salmonella* contamination in eggs. The probability of finding *S.* Typhimurium in egg contents is of the order of 1 in 100,000 eggs; a probability of only 0.001% (Attachment 6). One 'built-in' option is to use the Other option. This allows the user to manually enter the required probability each time a scenario is developed. An alternative approach was to modify the Risk Ranger weightings to better reflect the probabilities of contaminated eggs found in surveys directly (Tom Ross, pers. comm.). The original and alternative probabilities are presented in the table below. The selected probabilities were selected to adequately cover the range of probabilities for *Salmonella* contamination of eggs. The Other option is maintained to allow for the possibility of different contamination probabilities.

Comparison of original and alternative Risk Ranger options for Q6

Original	Alternative
Rare (1 in 1000)	1 in 100,000 or 0.001%
Infrequent (1%)	1 in 50,000 or 0.002%
Sometimes (10%)	1 in 25,000 or 0.004%
Common (50%)	1 in 12,500 or 0.008%
All (100%)	1 in 10,000 or 0.01%
Other	Other

Question 11: Effect of preparation before eating

The second Risk Ranger input that required modification was the question relating to the effect of preparation before eating. Experimental studies of egg meal preparation (Humphrey *et al*., 1989; Bates & Spencer 1997; Table 1) have found that different cooking practices result in large variations in the amount of *Salmonella* inactivation achieved. The original Risk Ranger input options where modified to reflect the experimental studies, especially the results of Humphrey. The original and alternative probabilities are presented in the table below. The new options are RELIABLY ELIMINATES (100% elimination), SUBSTANTIALLY REDUCES (5 log reduction in numbers, 99.999%), MODERATELY REDUCES (2 log reduction in numbers, 99%) and NO EFFECT.

Comparison of original and alternative Risk Ranger options for Q11

Original	Alternative
RELIABLY ELIMINATES hazards	RELIABLY ELIMINATES hazards
USUALLY ELIMINATES (99%) hazards	SUBSTANTIALLY REDUCES (5 log) hazards
SLIGHTLY REDUCES (50%) hazards	MODERATELY REDUCES (2 log) hazards
NO EFFECT on the hazards	NO EFFECT on the hazards
Other	Other

Calculation of the probability of illness

Risk Ranger has a log-linear dose response relationship between dose, the probability of illness and risk. This relationship implies that if the dose increases by a factor of ten, then the probability of illness and risk also increase by a factor of ten. However, the log-linear dose response relationship does not hold for all doses. For doses greater than the median infective dose, ID_{50}, the probability of becoming ill is taken to be 1. The probability of a consumer becoming ill following the consumption of a contaminated serving is the "Probability of Contamination of Raw Product per Serving" (value of Question 8) x "Probability of becoming ill from the consumption of a contaminated serving".

As there is no possibility of post-processing contamination, the probability of a consumer becoming ill following the consumption of a contaminated serving is given by:

$$\text{MIN}\left(\begin{array}{l}\text{the proportion of product contaminated (value of Q6) x}\\ 1,\\ \text{the effects of processing (value of Q7) x}\\ \text{the effect of post-processing handling/storage (value of Q9) x}\\ \text{the increase in the initial level of the factor required to reach } ID_{50} \text{ (value of Q10) x}\\ \text{the effect of preparation prior to eating (value of Q11)}\end{array}\right)$$

Summary of Original Risk Rating Spreadsheet Tool Inputs

Table 10.1: Weighting values used in the current model (V.1) [Ross and Sumner, 2002]

		Comment
1. Hazard severity		
SEVERE hazard—causes death to most victims	1	arbitrary weighting factors
MODERATE hazard—requires medical intervention in most cases	0.1	
MILD hazard—sometimes requires medical attention	0.01	
MINOR hazard—patient rarely seeks medical attention	0.001	
2. How susceptible is the consumer?		
GENERAL—all members of the population	1	100% of population
SLIGHT—e.g., infants, aged	5	20% of population
VERY—e.g., old, very young, diabetes, alcoholic etc.	30	3% of population
EXTREME—e.g. AIDS, transplants recipients, cancer patients, etc.	200	0.1% of population
		arbitrary weightings, but based on relative susceptibility to listeriosis, population estimates based on Australian health statistics
3. Frequency of consumption		
daily	365	simple algebra
weekly	52	
monthly	12	
a few times per year	3	
once every few years	0.3	
4. Proportion of population consuming		
all (100%)	1	arbitrary weighting factors
most (75%)	0.75	
some (25%)	0.25	
very few (5%)	0.05	

5. Size of population of interest		User selected or specified
6. Proportion of product contaminated?		
Rare (1 in a 1000)	0.001	0.01% of samples
Infrequent (1%)	0.01	1% of samples
Sometimes (10%)	0.1	10% of samples
Common (50%)	0.5	50% of samples
All (100%)	1	all samples
OTHER	user input	
7. Effect of process		
The process RELIABLY ELIMINATES hazards	0	arbitrary weighting factors
The process USUALLY (99% of cases) ELIMINATES hazards	0.01	
The process SLIGHTLY (50% of cases) REDUCES hazards	0.5	
The process has NO EFFECT on the hazards	1	
The process INCREASES (10x) the hazards	10	
The process GREATLY INCREASES (1000x) the hazards	1000	
8. Is there a potential for recontamination?		
NO	0	arbitrary weighting factors
YES—minor (1% frequency)	0.01	
YES—major (50% frequency)	0.50	
OTHER	user input	
9. How much increase from level at processing is required to reach an infectious or toxic dose for the average consumer?		
none	1	arbitrary weighting factors
slight (10-fold increase)	0.1	
moderate (100-fold increase)	0.01	
significant (10,000-fold increase)	0.0001	
OTHER	user input	
10. How effective is the post-processing control system?		
WELL CONTROLLED—systems in place, audited, well-trained staff	1	arbitrary weighting factors
CONTROLLED—systems in place, audited, well-trained staff	3	
NOT CONTROLLED—no systems in place, untrained staff	10	
GROSS ABUSE OCCURS	1000	
NOT RELEVANT—level of risk agent does not change	1	
11. Effect of preparation for meal		
Meal preparation RELIABLY ELIMINATES hazards	0	arbitrary weighting factors
Meal preparation USUALLY ELIMINATES (99%) hazards	0.01	
Meal preparation SLIGHTLY REDUCES (50%) hazards	0.50	
Meal preparation has NO EFFECT on the hazards	1.00	
OTHER	user-input value	

Sensitivity Analysis of Risk Ranger

A Sensitivity Analysis has been provided to illustrate how Risk Ranger inputs influence the three outputs: the Risk Ranking, the predicted illnesses per year and the predicted number of illnesses per million serving. The Risk Ranking obtained is a logarithmic scale between 0 and 100. A value of 0 represents no risk, while 100 represents a situation where every member of the population consumes a serving that contains a lethal dose every day. Each 6 unit change in the Risk Ranking scale is approximately a factor of 10 difference in the absolute risk estimate. It should be noted that the risk rating is independent of the population size but reflects relative risk to an individual within a population (Ross and Sumner 2002). Consequently combinations may have the same risk rating but different numbers of predicted illnesses.

For each of the 10 Risk Ranger questions the numerical values were varied by a factor of 10 (eg Hazard Severity was changed from Mild to Moderate and Minor, see Ross and Sumner, 2002 Table 10.1) and the changes in the outputs recorded. Summaries of the sensitivity analysis for two scenarios were yolk growth has not occurred and the cooking occurs during preparation (Scenario 1) and with yolk growth and no inactivation during preparation (scenario 20) are presented in Tables 10.2 and 10.3. The two scenarios (1 and 20) were selected as they represent egg utilisation pathways where a low dose (scenario 1) and a high dose (scenario 20).

A factor of 10 change in inputs was chosen for the sensitivity analysis as many of the weighting factors are set as 10-fold increments (eg Hazard severity). Also, as a 6 unit change in the Risk Ranking corresponds approximately to a factor of 10 difference in the absolute risk estimate, it is simple to assess the outputs using 10-fold changes in input values. Each factor was changed one at a time.

The effect of Q8 Potential for recontamination for shell eggs has not been considered in this analysis as it depends on the combined values of Q6 and 7. In relation to the efficacy of current washing practices this has been identified as an area that might be considered for further risk analysis.

The effect of Q8 Potential for recontamination of pasteurised commercial pulp has been considered in Table 16.1 (Scenarios 30-33).

Recontamination in the context of cross-contamination of egg dishes from other ingredients or the food preparation environment/process has not been included due to this being essentially unrelated to eggs and the lack of information on its' incidence, though it is likely to occur (Attachment 11).

In both scenarios the population size has no influence on the Risk Ranking. This is because the Risk Ranking is independent of population size and reflects the relative risk to an individual within a population. For the low dose scenario all other inputs result in a 6 unit change in the Risk Ranking.

For the high dose scenario the dose consumed is greater than the median infective dose, ID_{50}. As a result all of those people consuming a contaminated serving will become ill.

Table 10.2: Risk Ranger Sensitivity analysis for a (low dose) scenario where the YMT has not expired (Scenario 1)

Input	Change in input factor	Change in Risk Ranking*	Change in predicted illnesses per year	Change in predicted illnesses per million servings
Q1 Hazard severity	10x	6	None	None
Q2 Susceptibility of population	Not considered			
Q3 Frequency of consumption	10x	6	10x	None
Q4 Proportion of population consuming product	10x	6	10x	None
Q5 Population size	10x	None	10x	None
Q6 Probability of contamination of raw product per serving	10x	6	10x	10x
Q7 Effect of processing	10x	6	10x	10x
Q8 Recontamination	Not considered to occur			
Q9 Post-processing control	10x	6	10x	10x
Q10 Increase to infective dose	10x	6	10x	10x
Q11 Effect of preparation	10x	6	10x	10x

* Every change in Risk Ranking of 6 units is equivalent to a 10-fold change in risk

An example of the interpretation of these results is the initial number of *Salmonella* inside the egg. The initial number is controlled by Q10 "Increase to infective dose". For the scenarios it is assumed that 0.1 cfu/g are present in the egg before preparation. If this were to be increased to 1 cfu/g, a factor 10 increase in concentration, the Risk Ranking would increase by 6 units, the predicted illnesses per year and predicted illnesses per million eggs would increase by a factor of 10.

Table 10.3: Risk Ranger Sensitivity analysis for a (high dose) scenario where the YMT has expired (Scenario 20)

Input	Change in input factor	Change in Risk Ranking*	Change in predicted illnesses per year	Change in predicted illnesses per million servings
Q1 Hazard severity	10x	6	None	None
Q2 Susceptibility of population	Not considered			
Q3 Frequency of consumption	10x	6	10x	None
Q4 Proportion of population consuming product	10x	6	10x	None
Q5 Population size	10x	None	10x	None
Q6 Probability of contamination of raw product per serving	10x	6	10x	10x
Q7 Effect of processing	10x	None	None	None
Q8 Recontamination	Not considered to occur			
Q9 Post-processing control	10x	None	None	None
Q10 Increase to infective dose	10x	None	None	None
Q11 Effect of preparation	10x	None	None	None

* Every change in Risk Ranking of 6 units is equivalent to a 10-fold change in risk

Scenario 20 assumes that extensive growth of *Salmonella* has occurred and meal preparation has no influence on the hazard. The dose consumed is greater than the median infective dose. As a result a factor of 10 increase in the number of cells will have no effect on the risk estimates.

The sensitivity analysis for the two scenarios highlighted that the Risk Ranger responses were identical for the questions 1 to 6. However, differences between the scenarios were found for questions 7, 9, 10 and 11. For scenario 1 a factor of ten change in the risk Ranger inputs always resulted in changes to the outputs, while for scenario 20 no changes were found. The difference between the two scenarios is the log-linear dose-response relationship built into Risk Ranger. For doses (=the number of *Salmonella* cells consumed) less than ID_{50}, a factor of 10 change in an input results in a factor of 10 change in the risk outputs (square in Figure 10.1). For scenarios where extensive growth inside the egg has occurred and there is no reduction in hazard levels during preparation a factor of 10 change in the Risk Ranger inputs for question 7, 9, 10 or 11 will result in no change to the risk outputs (diamond in Figure 10.1). This is because the dose consumed is much greater than the ID_{50} value, and a factor of 10 change in a single input will not reduce the dose to less than ID_{50}.

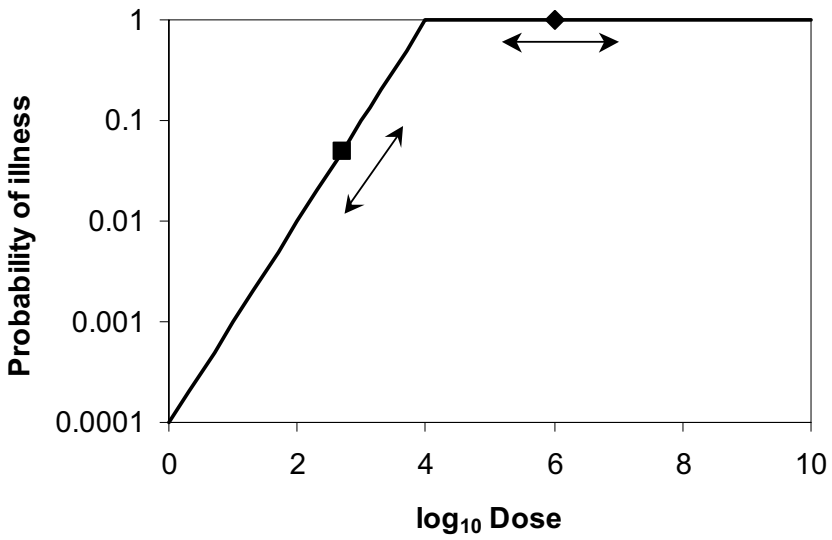

Figure 10.1 *Salmonella* spp. dose response relationship used in the modified Risk Ranger (ID_{50} ≈ 10,000 cells)

Example: Sensitivity Analysis for Non-Cage Produced Eggs

Risk management question: "What if" the *Salmonella* prevalence is greater for non-caged compared to caged egg production?

An uncertainty raised in the 2nd workshop was whether alternative production systems may result in higher *Salmonella* prevalence in eggs. It is recognised that eggs laid in nest boxes are more likely to become soiled, compared with eggs produced in caged systems. The trans-shell movement of bacteria into the egg contents is thought to largely occur in the minutes prior to the hardening of the egg cuticle. As a result faecal contamination soon after lay is a key factor in the introduction of bacteria, including *Salmonella,* into egg contents.

Two egg production scenarios for non-cage produced eggs are considered: the current situation where about 13% of all eggs are non-caged; and a 'future' scenario where welfare concerns result in a large proportion (50%) of total egg production in Australia are non-caged produced.

From the Risk Ranger sensitivity analysis (see above) it is seen that a factor of 10 increase in the prevalence (Risk Ranger Q6) results in a factor of 10 increase in risk i.e a change in prevalence is reflected proportionally in a change in consumer exposure.

For the case of non-cage production, the increase in risk due to a greater *Salmonella* prevalence is limited by the smaller number of eggs produced in these systems. For example a 30% increase in *Salmonella* prevalence above the baseline value of 0.004% (Attachment 6), results in a 3.9% increase in the predicted cases of illness per year (Figure 10.2)[1]. For the 50% non-cage production scenario, the increase in the *Salmonella* prevalence has a greater impact on the predicted number of illnesses per year as more non-cage eggs are produced. For this scenario a 30% increase in prevalence above the baseline results in a 15% increase in the predicted illnesses per year.

[1] The increase in predicted illnesses results due to an increase in *Salmonella* prevalence for non-caged production can be calculated from 13% (for non-caged production) x 30% (increase in prevalence) = 3.9% overall increase.

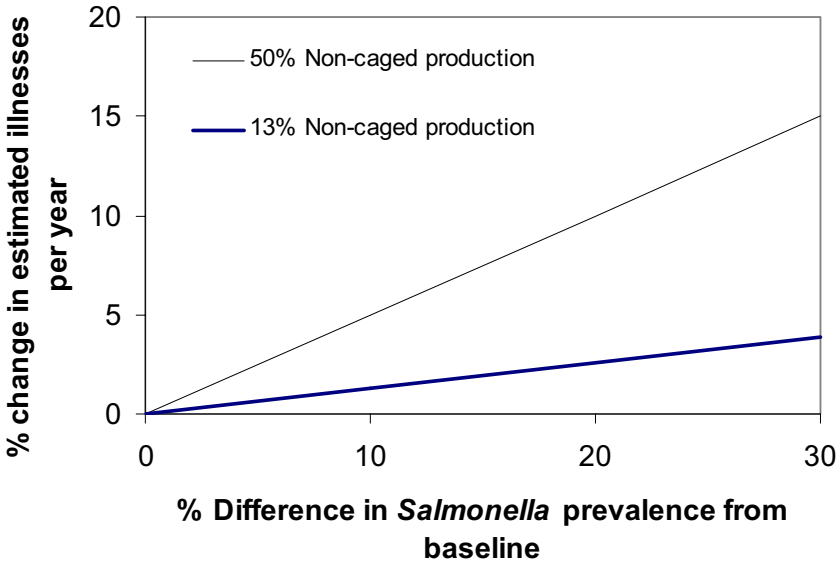

Figure 10.2: Estimated change in predicted number of illnesses per year due to changes in Salmonella prevalence from non-cage produced eggs. The baseline prevalence for all non-SE *Salmonella* is assumed to be 0.004%. Two scenarios are presented: 13% and 50% non-cage production.

The impact of an increased *Salmonella* prevalence for non-caged systems will depend on the uptake of these systems and the magnitude of the prevalence above the baseline prevalence.

Example: Sensitivity Analysis for Washing Eggs

An additional example of the use of Risk Ranger is to evaluate the impact of changes to the prevalence of internal contamination of eggs due to improper washing conditions. Quantitative data for this scenario is not available for Australian washing practices. However, to illustrate the likely outcome, assuming a 50% increase in the prevalence due to washing was evaluated using Risk Ranger. The Risk Rating changed by only 1 unit[2], but both the predicted illnesses per year and predicted illnesses per million servings increased by 50%.

[2] The Risk Ranking is scaled logarithmically between 0 and 100. An increment of six "Risk Ranking" units correspondings to approximately a factor of 10 difference in the absolute risk. Increasing the prevalence due to washing by 50% will leading to corresponding increases in the predicted illnesses per year and illnesses per million servings. The Risk Ranking will then increase by (1.5/10) x 6 which is approximately 1.

Attachment 11: Cross-Tabulation of 26 *Salmonella* Outbreaks

Table 11.1: Cross-tabulation of 26 *Salmonella* outbreaks identified by OzFoodNet as having epidemiological links with eggs (Source SAR-42A)

	Non-Commercial										Both		Commercial								Unknown					
Case ID	**1**[1]	**6**	**7**	**8**	**9**	**13**	**20**	**28**	**37**	**38**	**18**[2]	**22**	**5**	**19**	**23**	**25**	**30**	**31**	**34**	**36**	**2**	**3**	**4**	**16**	**17**	**24**
Serovar	TM	H	H	TM	H	M	TM	TM	TM	Had	TM	TM	P	TM	TM	V	TM	TM	TM	TM	TM	TM	TM	TM	TM	TM
PT	9	16	1	8	1		135a	170	135a	22	135	9		8	135 145	34	135	64	126	RDNC A041	9	135	135	135a	64	U307
Food isolate	Y	Y		Y		Y	Y	Y			Y		Y	Y	Y		Y	Y		Y						
Source Invest.	Y	Y		Y	Y			Y	Y		Y		Y	Y		Y	Y			Y						Y
Source +/-	+	-		-	-			-	+		+		-	-		+	-			-						+
Analytical epidemiol.												Y					Y		Y			Y				
Cracked/ Dirty		Y	Y	Y					Y						Y								Y			
Cooked/ Uncooked	U	C	U	U	U	C	U	U	C	C	U	U	U	U	U	?	U	C	?	C	U	C	C	C	?	U
Temp. Abuse	Y	Y		Y		Y							Y	Y										Y		
Vulnerable population			Y		Y				Y		Y					Y				Y	Y	Y				
Cross-Contam.		Y		Y	Y	Y						Y	Y	Y		Y	Y	Y	Y			Y			Y	
Serovar Layer Environ	N	N	N	N	N	Y	N	N	N	N	Y	N	N	N	Y N	Y	Y	N	N	N	N	Y	Y	N	N	N

Serovars abbreviations: TM Typhimurium, H Heidelberg, M Mbandaka, Had Hadar, P Potsdam, V Virchow
PT Phage Type
Food isolate: Outbreak serovar isolated from the implicated food containing egg as an ingredient
Source investigated: Whether egg layer source environment investigated using drag swab for *Salmonella* detection
Source: +/- : Whether egg layer source *Salmonella* spp. positive or negative
Analytical epidemiol.: Analytical epidemiological methods demonstrated a statistically significant association with a food vehicle containing eggs as an ingredient
Cracked/Dirty: Either cracked or dirty eggs used for implicated food or in associated food preparation premise
Cooked/Uncooked: Egg or egg product in implicated food in either cooked or uncooked state
Temperature abuse: Investigators recorded inappropriate storage temperature for the implicated food
Vulnerable population: Outbreak principally affected aged care, hospital or child care cohorts
Cross contamination: Investigators recorded the likelihood of cross contamination from either the food preparation environment, other ingredients or food handlers
Serovar Layer Environ: Isolated previously from commercial layer environments in Australia; Data from NSW and Queensland investigations (Cox, 1993; Cox *et al.,* 2002) and commercial layer source investigations detailed in this Table.
[1] Both non-commercial and commercial source, but positive isolation only from backyard source
[2] Positive egg source not specified
Outbreak 6 (Table 11.1) in which unpasteurised egg pulp was implicated as the source of contamination90is modelled in Scenario 26 (Tables 16 and 17)

Attachment 12

Enhancement of Attribution

Throughout AECL Project SAR-42A and this project a lack of consensus in relation to attribution criteria for *Salmonella* outbreaks was apparent. Suggestions, in addition to the issues identified in the hazard identification section (Part 1 Section 3.1) are listed.

- The national industry is promoting the concept of a national SE (freedom) monitoring program similar to the NSW program. This would provide data on any regional differences and a wider perspective on industry serovars, phage types (Tables 1 and 5) and flock incidence.
- In our work it has become apparent that not all isolates from industry QA monitoring are submitted for typing. This represents a "loss" of useful information.
- New molecular techniques (eg Multi-Locus Sequence Typing) may offer assistance in proving the chain of evidence from outbreaks in general and particularly where eggs are suspected.
- Through our work we have provided OzFoodNet with questions for use in investigations and contamination data through the supply continuum (AECL Project SAR-42A) which may assist in the attribution process. Additional considerations that are particularly relevant are the age of eggs implicated (Attachment 3) and the likely impact of cooking on log reduction of *Salmonella* of the suspected food (Section 3.3, Table 6). Foods implicated in the outbreaks reviewed in AECL Project SAR-42A are categorised according to their likely cooking impacts (Table 12.1).
- Greater collaboration of stakeholders across sectors would be useful in establishing common ground and identifying the important data gaps in the areas of greatest risk where additional information will assist the better estimation of risk.

Table 12.1: Thermal inactivation of *S.* Typhimurium in typical egg meals (after Humphrey *et al.*, 1989; Spencer & Bates, 1994) and foods implicated in 26 outbreaks reviewed in AECL Project SAR-42A

Thermal treatment	Decimal reduction	Types of meal	Foods implicated in 26 outbreaks* (# of outbreaks)
None	No effect (NE)	Raw egg drinks, some desserts	Raw egg drink (3) Mayonnaise (2) Caesar salad/mayo (2) Pies – added post-cooking (2) Tiramisu (2) Hedgehog (1) Parfait (1) Gelati (1) Mock ice cream (1)
Light cooking	Moderate reduction (MR)	Boiled 4 min, fried ("sunny side up"), microwave	Egg sauces (1)
Medium cooking	10,000-fold Substantial reduction (SR)	Fried ("easy over"), lightly scrambled or omelette, pasta	Pastry/custard tart (2) Pasta (1) Undercooked patties (1)
Heavy cooking	Reliably eliminates (RE)	Hard boiled or scrambled, cakes, biscuits	Hard boiled (4) Baked dish (1) Fried ice cream batter (1)

* Estimated categories from common recipes

Attachment 13

Greg Hooper & Associates
Pesticides & Veterinary Medicines Consultants

EGG INDUSTRY RISK PROFILE

CHEMICAL HAZARDS THROUGH RESIDUES IN EGGS

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EGG INDUSTRY RISK PROFILE
CHEMICAL HAZARDS THROUGH RESIDUES IN EGGS

EXECUTIVE SUMMARY

The profiling of chemical hazards (residues in eggs) is an important food safety consideration. The possible health effects of pesticide and veterinary drug residues in food as well as other contaminants have, and will continue to be of, significant interest and concern to consumers who are probably more aware of chemical residues than any other food safety issue. Consumers naturally become concerned when residues of pesticide and veterinary chemical products are detected in food, when products previously assessed as safe and effective are withdrawn from the market, when regulatory agencies appear to take inconsistent decisions or there is a belief, correctly or not, that regulatory processes are not of sufficient rigor to ensure public confidence in the wholesomeness of food products.

Methods

For chemicals of importance to the egg industry and as part of the overall risk identification process, this report highlights possible risks to food safety by identifying, with the assistance of regulatory and government agencies as well as experts within the egg industry:

- chemical products and their active ingredients used within the Australian egg industry (with emphasis placed on those of importance to the industry),
- MRLs for eggs, identifying gaps,
- Acceptable Daily Intakes (ADIs) for key active ingredients.
- Codex MRLs for key active ingredients,
- pesticides that might carry-over from crops into poultry feed and then into eggs,
- any health and safety risks that have been noted in relation to the identified key chemicals (pesticides and veterinary drugs)

Chemicals approved for use in egg industry were identified from the Australian Pesticides and Veterinary Medicines Authority's database of registered chemical products. Approximately 250 chemical products were identified but the database was such that products specifically approved (or specifically not permitted) for use in the egg industry could not always be identified. Those chemical products used within, and of importance to the Australian egg industry were determined with the assistance of experts with extensive experience in the poultry and egg industries, particularly in respect to poultry health, nutrition and chemical use.

An indication of possible risk to public health arising from residues in eggs was obtained by evaluating the results from the National Residue Survey (NRS) egg program over the past 3-4 years to determine those chemicals that were showing up as residues in eggs. The NRS cereal grains program provided an indication of those chemicals that could possibly carry over into eggs through poultry diets.

Total Diet Studies undertaken by Food Standards Australia New Zealand (FSANZ) were also reviewed to identify the actual level of residues of pesticides, veterinary drugs and other contaminants such as heavy metals in the Australian diet. The Total Diet Study also allowed a comparison of actual residue intake against a public health standard viz the Acceptable Daily Intake (ADI) set by the Australian Department of Health and Ageing. These results were

therefore more relevant in identifying chemicals of possible food safety and public health significance. Recent publication of the results of the National Dioxin Program provided an indication of the level of dioxins in eggs and the opportunity for comparison with other agricultural commodities.

Results

Some 20 pesticides and veterinary drugs were identified as being of importance to the Australian egg industry. These included registered chemicals, chemicals approved by way of a permit and chemicals used under the provisions of State control-of-use legislation that allows veterinarians to prescribe chemicals 'off-label' under certain conditions. The chemicals used included the insecticides azamethiphos, carbaryl, maldison, permethrin and pyrethrum, the antibiotics bacitracin, chlortetracycline, flavophospholipol, lincomycin and tiamulin, the coccidiostats amprolium, lasalocid, monensin, nicarbazin, salinomycin, spectinomycin and dewormers such as levamisole and piperazine. Also identified were amoxycillin, sulfadiazine, sulfadimidine, sulfaquinoxoline, toltrazuril and trimethoprim, which are all currently the subject of minor-use consideration by the APVMA. There were also 21 pesticides that, on the basis of detection in the NRS grains program and/or their lipophilic nature were identified as chemicals that had the potential to carryover into eggs through the diet. With the exception of methoprene, MRLs were set for all chemicals with carryover potential.

There were no chemicals identified where the level of residue detected in monitoring programs was above the MRL. However, several of the chemicals identified as being of importance to the egg industry did not have MRLs established for eggs (amoxycillin, monensin, nicarbazin, piperazine, sulfadiazine, sulfadimidine, sulfaquinoxaline, tiamulin, toltrazuril and trimethoprim). Furthermore, in a number of instances (amprolium, piperazine and tiamulin), no ADI had been set. Nevertheless, it is understood that State control-of-use laws do not prohibit the use of these chemicals by veterinarians.

The Australian Total Diet Survey confirmed that for individual chemicals of interest (and where included within the scope of the Survey) actual residue intake was well below the established ADI and that in several cases, no residue was detected in any foods, including eggs. Levels of contamination by heavy metals and dioxins were low and at levels of no public health significance.

For most of the chemicals of interest to the egg industry, there were no Codex MRLs in place. This may reflect the fact that the chemicals are 'old' and that there has been no priority for Codex consideration because whole eggs (as against egg products) are not a significant item of international trade. In some cases, Codex MRLs for eggs have been deleted following periodic review of the chemical. A lack of international support for the chemical or the absence of suitable residue data may have prevented those MRLs being maintained. The absence of Codex MRLs is not necessarily an indicator of a food safety concern.

There was no direct evidence of off-label use by *egg producers* that, under State and Territory law is illegal except in the Australian Capital Territory. Off-label use by *veterinarians* is permitted in all States and Territories unless the label carries specific use restraints. Where veterinarians do prescribe off-label, it is an offence in Queensland, Victoria, Tasmania, and South Australia to cause violative residues in animal products or to give advice resulting in violative residues. Similar offence provisions are proposed in New South Wales, Western Australia and the Northern Territory. Neither are offences in the ACT.

Discussion

Based on the available information, there is no evidence that residues of pesticides, veterinary medicines or other contaminants present a food safety or public health risk. In fact the results

suggest that, on the basis of the scope of current monitoring programs, eggs are generally residue-free though some heavy metals have been detected.

The absence of domestic MRLs and public health standards (ADIs) for some pesticides and veterinary drugs of importance to the egg industry is however of some concern. If residues of those chemicals were detected at any level, then those eggs would be in breach of food standards and State food laws. The absence of such standards may also lead to a perception of a food safety concern. The legitimate off-label use by veterinarians of chemicals without MRLs or ADIs having been set may, over time, cause public health and other regulatory authorities to act to totally remove industry access to those products. This is already occurring through the placement of restraints on labels that prevents all off-label use. To avoid essential chemicals being lost, this situation needs to be formally addressed in cooperation with egg producers, product registrants and the appropriate regulatory authorities. The egg industry needs to be clear about the underlying regulatory basis for 'approved' chemical use and the risks that may pose to the wider industry.

With the exception of antibiotic use, there is, at this time, no known public health concern associated with any of the specific products identified as being of importance to the egg industry. The issue of antibiotic use and the possibility of resistance development in humans has been investigated through the Joint Expert Technical Advisory Committee on Antibiotic Resistance (JETACAR) with the cooperation of user industries. As a result, regulatory processes have been modified and specific product reviews are currently underway. The outcome may have implications for the egg industry should antibiotic products be withdrawn from the market.

There is also a general international concern over organophosphorous and carbamate insecticides that may manifest itself in further regulatory reviews (such as that currently underway in respect to carbaryl and associated occupational health and safety concerns) and possible removal of some products over time. The use of dimetridazole is also not permitted in several overseas countries and its use in Australia has recently been reviewed by the APVMA which has concluded that, since an ADI for dimetridazole can no longer be supported, the registration of products currently used in food-producing animals will be cancelled. However, the APVMA has recognised that dimetridazole is an important tool in the management of blackhead in poultry and that there are no registered alternative chemicals available to treat outbreaks of this disease. The APVMA therefore intends to explore options in consultation with the poultry and egg industries to permit the limited use of dimetridazole in breeder stock.

While there is no immediate concern in respect to the level of contaminants in eggs, the level of dioxins should be closely monitored.

Australia places considerable effort in residue monitoring for both trade and public health purposes. However despite this, the overall level of residue monitoring information for eggs provided by way of the National Residue Survey and the Australian Total Diet Survey is limited, especially in regard to inhibitory substances and individual and more modern pesticides and veterinary drugs. Confidence in the residue status of eggs would be enhanced if the scope of residue monitoring programs were expanded to reflect contemporary use practices within the industry.

This study has also identified other chemical issues facing the egg industry (but outside the scope of this review) including the loss of valuable chemicals as a result of reviews of old chemicals, concerns in regard to occupational health and safety, and the development, registration and availability within Australia of new chemicals for predominantly minor-use industries such as the Australian egg industry.

Implications

This study confirms that chemical risks to the egg industry are generally very low. However the absence of MRLs and ADIs for important chemicals presents a high risk for the industry should residues be detected.

While in most circumstances industries facing similar problems would work with product registrants and regulatory agencies to rectify the problem, the issue may not be so straightforward in respect to the egg industry. This is because the chemicals in use are generally old, and as the industry is regarded as a 'minor use industry', there may be little or no commercial incentive to encourage product registrants to generate the necessary data, often at considerable cost, to defend their products and allow appropriate standards to be put in place.

If the appropriate standards are not set for chemicals used in the egg industry, then there is a risk that any future detection of residues will create concerns in respect to food safety. Consumer confidence in eggs may be significantly eroded. Undue reliance on State control-of-use provisions and the ability of veterinarians to prescribe off-label, particularly in the absence of MRLs may add to that concern. A program of cooperation between the egg industry, chemical registrants and the APVMA to achieve minor-use permits and MRLs with appropriate supporting data (similar to that which is in place for the horticultural industry) would be useful.

Recommendations

It is recommended that:

- The Australian egg industry moves to ensure that, as appropriate, all chemicals used in the industry have MRLs established.

- An appropriate egg program be developed within the National Residue Survey that reflects contemporary chemical use practices within the egg industry.

- The egg industry explore in consultation with the APVMA, a minor-use program aimed at securing minor use permits and MRLs for chemicals of importance to the egg industry and therefore less reliance on off-label use by veterinarians.

- The Australian egg industry works closely with Food Standards Australia New Zealand in their consideration and setting of appropriate food standards for dioxins.

- The egg industry continues to recognise chemical residues as an issue of public and political interest and a potential area of food safety concern.

1. Introduction

1.1 Background to the Review

The "Through Chain Risk Profile for the Australian Egg Industry" Project has, in respect to chemical hazards through residues, objectives specified by the Australian Egg Corporation Limited (AECL) which include the identification of;

- public health hazards that enter any point of the food chain for eggs and egg products produced in Australia and rank them in terms of risks to the consumer
- hazards of potential high risk where too little information exists for a confident ranking of risk
- potential management strategies for the identified hazards

The profiling of chemical hazards (residues in eggs) is an important food safety consideration. The possible health effects of pesticide and veterinary drug residues in food as well as other contaminants have, and will continue to be of, significant interest and concern to consumers. Consumers are probably more aware of chemical residues than any other food safety issue. They naturally become concerned when pesticide and veterinary chemical products are detected in food, when products previously assessed as safe and effective are withdrawn from the market, when regulatory agencies appear to take inconsistent decisions or there is a belief, correctly or not, that regulatory processes are not of sufficient rigor to ensure public confidence in the wholesomeness of food products.

Unfortunately, consumer confidence in certain overseas regulatory systems has been seriously eroded in recent times by food safety issues such as food irradiation, genetically modified (GM) foods, BSE, antibiotics, dioxin-contaminated feed given to livestock and incidents of food poisoning by microbiological contamination.

For chemicals of importance to the egg industry, and as part of the overall risk identification process, this report seeks to identify possible risks by identifying:

- chemical products and their active ingredients used within the Australian egg industry (with emphasis placed on those of importance to the industry),
- MRLs for eggs, identifying gaps,
- Acceptable Daily Intakes (ADIs) for key active ingredients. This will help any public health assessment of residues,
- Codex MRLs for key active ingredients,
- pesticides that might carry-over from crops into poultry feed and then into eggs,
- any health and safety risks that have been noted in relation to the identified key chemicals (pesticides and veterinary drugs),

An assessment of risk to public health will then be determined by

- Evaluating recent NRS results for eggs over the past 3-4 years
- Reviewing recent FSANZ Total Diet Studies
- Commenting on the magnitude of residues and their health and safety implications having regard to the identified ADIs

In addition to pesticides and veterinary medicines, the current situation with environmental contaminants such as dioxins and heavy metals has also been outlined.

1.2 Regulation – Pesticide and Veterinary Drug Residues and Food Safety

To understand the chemical risk assessment process, and especially the assessment of possible risks to public health arising from residues in food, it is useful to have some appreciation of the regulatory system and of food quality and safety standards such as the Maximum Residue Limit (MRL)[3] and the Acceptable Daily Intake (ADI)[4].

The Australian Pesticides and Veterinary Medicines Authority (APVMA) registers pesticides and veterinary chemical products supplied, sold or used in Australia. The Agricultural and Veterinary Chemicals legislation requires that the APVMA must be satisfied that when the product is used according to its use-pattern and associated label instructions, it will not result in any appreciable risk to consumers, other persons handling, applying or administering the chemical, the environment, target crops or animals and trade in agricultural commodities. The APVMA must also be satisfied that every product is efficacious, ie it will control the pest or disease as claimed.

Registration of pesticides and veterinary chemicals involves a thorough assessment of risk and the establishment of risk management measures that usually form the label instructions, the label itself being a legal document. Departure from label instructions, unless authorised, for example by a Permit, constitutes illegal use, and is an offence under State law.

The assessment of pesticides and veterinary chemicals in food to ensure potential residues are within safe limits is a key element of the registration process and involves three main assessment steps, viz a toxicological evaluation, the setting of a Maximum Residue Limit (MRL) and the evaluation of dietary exposure.

Toxicological Evaluation

The Department of Health and Ageing on behalf of the APVMA undertakes the toxicological evaluation of pesticides and veterinary medicines. Extensive data are evaluated to determine the potential for adverse health effects and to determine public health standards, in particular, an Acceptable Daily Intake (ADI) and the Acute Reference Dose (ArfD). Health authorities also recommend poisons scheduling classification and first aid and safety instructions.

Acceptable Daily Intake (ADI)

The ADI is the amount of chemical (expressed as mg/kg body weight/day) that may be consumed every day for an entire lifetime without causing an appreciable risk to health. The ADI is determined from toxicological studies, the object of which is to explore the overall spectrum of toxicity of the chemical and to set a no observable effect level (NOEL). The NOEL is defined as the highest dose level in mg/kilogram bodyweight/day that produces no observable effect in the most sensitive test animal species. The NOEL, usually derived from long-term toxicity studies, is used to set the ADI for humans by applying a safety factor ranging between 1/10 and 1/2000 to the NOEL depending on the data available and any toxicological issues of concern. A safety factor of 1/100 is usually applied.

$$ADI = NOEL \times {}^{3}60 \times \text{safety factor (mg/kg bodyweight/day)}$$

[3] Throughout this review, the Australian MRLs quoted are those established by the APVMA and reported in " The MRL Standard – Maximum Residue Limits in Food and Animal Feedstuffs", May 2004.

[4] The Acceptable Daily Intakes (ADI) quoted in this report are those set by the Australian Department of Health and Ageing, 30th June 2004.

[3] 60 refers to average body weight of 60kg

The concept of the ADI has not just arisen in response to more recent food safety concerns. It was first developed in 1966 by the FAO/WHO Joint Meeting on Pesticide Residues (JMPR) and has stood the test of time, being reaffirmed on several occasions as an appropriate measure of consumer safety.

Acute Reference Dose

The ArfD is an estimate of the maximum amount of a chemical in food or water (again expressed as mg/kg of body weight) that can be ingested in one meal or one day without appreciable risk to the consumer; it relates to an acute dose consumed on one day. (As background, the Allowable Daily Intake (ADI) relates to the lifetime daily intake).

Maximum Residue Limits

The maximum residue limit (MRL) is the highest concentration of a residue of a pesticide or veterinary drug that is legally permitted or accepted in a food or animal feed. The MRL is determined by residue trials. The concentration is expressed as mg/kg of the food commodity.

MRLs are regulatory standards that assist in the monitoring of residues to ensure that products have been used in accordance with the approved label instructions ie in accordance with "good agricultural practice" (GAP). Good agricultural practice includes the nationally authorised safe uses of pesticides under actual conditions necessary for effective and reliable pest control. It encompasses a range of levels of pesticide or veterinary drug application up to the highest authorised use, applied in a manner that leaves a residue that is the smallest amount practicable. The MRL is defined as the maximum concentration of a chemical residue (expressed as mg/kg), that is legally permitted in or on food commodities and animal feeds.

MRLs are set for all types of raw food commodities (and some processed commodities) where the use of the pesticide or veterinary drug is required for efficient production including crop or animal protection. Foods may be either of plant or animal origin and may be used for human and animal consumption.

The establishment of MRLs requires the evaluation of extensive residue trials conducted to determine the level of residue that is likely to be present in the food following the use of the chemical in accordance with good agricultural practice, including all the label instructions proposed for the chemical product. Some trials are carried out under maximum use conditions ie at the maximum application rate, maximum frequency of application and often up to twice the application rate to assess residues from possible misuse or misadventure. This provides an indication of the likely level of residue in the most extreme of situations.

Other factors taken into consideration in the setting of an MRL include how accurately the chemical and possible metabolites of toxicological significance can be measured, how rapidly the plant or animal metabolises the residue, frequency of use, bio-accumulation and any effects of further food processing. The MRL should be set at a level no greater than is needed to cover GAP.

The point that is often not appreciated is that the MRL can be based on residue trials alone and there need be no link with or consideration of the public health and safety issues which are assessed in a separate and parallel process. Clearly, however, this would be unacceptable. To ensure that the maximum residue limit is acceptable from a public health point of view, the likely level of residue in individual foods and the diet needs to be *compared with* a public health standard which is the Acceptable Daily Intake (ADI). The MRL is, however, *not determined directly by* the ADI.

Before confirming the MRL, it must be established through dietary exposure evaluation, that the sum of all residues from all food uses of the chemical will not exceed the ADI. This

provides added assurance that there will be no risks to food safety. The establishment of withholding periods further ensures that residues are below the MRL. If residues are likely to exceed the ADI then that use should not be approved unless changes are made to GAP, in particular, use-patterns. Alternatively, use-patterns associated with other uses that contribute to the ADI being excessively "consumed" or exceeded can be modified or removed from the label and prohibited.

Dietary Exposure Evaluation

The short and long term dietary exposures to a chemical are estimated by calculating the National Estimated Daily Intake and the National Estimated Short Term Intake respectively. Information used in these calculations include food consumption data from subgroups of the population, the approved use of the chemical, expected levels of residue in raw commodities and data establishing chemical breakdown over time including during transport, storage and processing.

The best estimates of long-term dietary exposure are based on surveys of foods such as the Australian Total Diet Survey (the Market Basket Survey) which for individual chemicals in the diet, determines exposure against the ADI ie the safe level of human lifetime exposure. As the concept of dose-response is still fundamental to establishing the safety of chemical residues in food, low exposure equates to low risk, while high dietary exposure will be of concern to regulators, food producers and the public.

1.3 Monitoring Residues in Food for Compliance with Food Safety Standards

A number of programs exist to monitor compliance against Maximum Residue Limits and Acceptable Daily Intakes. Those of national importance are the National Residue Survey conducted by the Department of Agriculture, Fisheries and Forestry and the Australian Total Diet Study, previously the Market Basket Survey, conducted by Food Standards Australia New Zealand.

National Residue Survey

The NRS objectives are to underpin export and domestic marketing initiatives of participating industries and thus to enhance the value of Australian agricultural industries and to maintain consumer confidence by providing independent, authoritative and scientifically based evidence supporting the chemical residue and contaminant status of the products covered by NRS residue monitoring activities. The NRS also provides scientific advice on residues and contaminants and contributes to the management of residue-related issues.

Residue monitoring is an important element of an overall strategy to minimise unwanted residues and environmental contaminants in food. It serves to identify potential problems and indicates where follow-up action is required. Residue monitoring is also important as a measure of overall product quality, particularly for exporting countries such as Australia.

Australian Total Diet Study

The purpose of the Australian Total Diet Study (ATDS) is to estimate the level of dietary exposure of the Australian population to a range of pesticide residues, contaminants and other substances that can be found in the food supply. In the ATDS, dietary exposure is estimated by determining the level of the substance in foods by direct analysis, and then multiplying this by the amount of that food consumed in the diet of Australian adults and children. Dietary intakes for pesticides are compared as a percentage of the Acceptable Daily Intake (ADI). Foods examined in the ATDS are prepared to a 'table ready' state before being analysed.

Summary
Unlike other sources of possible food contamination and associated food safety concerns, the use of pesticides and veterinary medicines is anticipated and therefore closely regulated. The level of residues in treated food commodities is determined and assessed for safety to consumers. Dietary exposure assessment is a key element in the risk assessment of pesticides and veterinary chemicals. MRLs are regulatory standards established to define the highest concentration of a residue permitted in food while ADIs are toxicologically derived public health standards that are measures of consumer exposure and possible risk.

The National Residue Survey determines the compliance of raw agricultural commodities against Maximum Residue Levels. Compliance with MRLs is an indicator that good practices have been followed in the use of chemical products.

The Total Diet Study determines the level of actual dietary intake of residues after cooking and processing ie in the table ready state. Intake levels are compared against the Acceptable Daily Intake (ADI). The Total Diet Study is a measure of consumer safety.

2. Pesticides and Veterinary Medicines Used in the Production of Eggs

Pesticides and veterinary medicines that are permitted for use in egg and poultry production are those registered or otherwise approved by the APVMA. The list of APVMA registered products for use in poultry production is at Appendix A. The list of some 250 products includes a variety of products that fall within the definition of an agricultural and veterinary chemical product as defined in the Commonwealth *Agricultural and Veterinary Chemicals Code Act 1994*. The list includes antibiotics, coccidiostats and insecticides as well as vaccines and enzymes.

Clearly not all of these products are used widely throughout the egg production industry. Products gain and lose favour and in respect to pesticides and veterinary drugs, registrants seek to maintain registration to fill niche markets or for other commercial reasons though use may at times be limited. In some cases, registrants may choose to maintain a product registration but not offer the product for sale.

Products that have generally wide acceptance within the egg industry were determined in consultation with the industry and with the assistance of Dr Tom Grimes of Grimes Consulting Pty Ltd and Dr Peter Scott, Managing Director, Scolexia, Animal and Avian Consultancy. With extensive experience in the poultry industry, both Dr Grimes and Dr Scott were able to review the list of APVMA registered products and the pesticide and veterinary chemical active ingredients present in those products (often in multiple products) and advise of those which were important and generally widely used in the industry. From this, maximum residue limits (MRLs) and Acceptable Daily Intake (ADI) figures, which apply to the active ingredients in those products, could be determined.

It should be noted that chemicals used within the industry are (or should be) registered or approved by way of a permit issued by the APVMA. State control-of-use laws also allow veterinarians to prescribe off-label. The situation in respect to off-label use is outlined in Section 6.

Vaccines, enzymes, vitamin and mineral supplements are not regarded as presenting a public health or food safety risk and therefore MRLs and ADIs are not established. These were therefore regarded as being of low risk and were not pursued further in this study.

The most important active ingredients in pesticide and veterinary drug products used in the egg industry, their Australian and Codex MRL for eggs (where specified) and ADI are listed in Table 13.1.

Table 13.1 Pesticides and Veterinary Medicines with Significant Use in the Egg Industry

Insecticides				
	MRL (mg/kg)	**Codex MRL (mg/kg)**	**ADI mg/kgbodywt/day**	**Comment**
Azimethiphos	0.05	Not listed	0.003	
Carbaryl #	T0.2	0.5	0.008	Codex MRL to be withdrawn
Cyfluthrin	0.01	Not listed	0.02	
Maldison	1	Not listed	0.02	
Permethrin	0.1	0.1	0.05	
Pyrethrum	Exempt	Not listed	0.04	

[#] Currently under review by APVMA T denotes that the MRL is temporary pending further data.

Antibiotics				
	MRL (mg/kg)	**Codex MRL (mg/kg)**	**ADI mg/kgbodywt/day**	**Comment**
Amoxycillin♠	Not listed	Not listed	0.2	
Bacitracin	0.5	Not listed	0.1	
Chlortetracycline	0.2	Not listed	0.003	
Flavophospholipol*	0.02	Not listed	0.3	
Lincomycin	0.2	Not listed	1	
Spectinomycin	2	Not listed	1	
Tiamulin	Not listed	Not listed	Not set	

Note: * For growth promotion

Coccidiostats				
	MRL (mg/kg)	**Codex MRL (mg/kg)**	**ADI mg/kgbodywt/day**	**Comment**
Amprolium	4	Not listed	Not set	
Dimetridazole #	Not listed	Cannot be set	Deleted	Under review
Lasalocid	T*0.05	Not listed	0/001	
Monensin	Not listed	Not listed	0.01	
Nicarbazin	Not listed	Not listed	2	
Salinomycin	*0.02	Not listed	0.01	
Tolrazuril♠	Not listed	Not listed	0.01	Label Restraints

[#] Reviewed by APVMA. Public comment sought on regulatory proposals

T denotes that the MRL is temporary pending further data.

* indicates that the MRL is set at the limit of analytical quantitation ie no residues should be present.

Dewormers				
	MRL (mg/kg)	**Codex MRL (mg/kg)**	**ADI mg/kgbodywt/day**	**Comment**
Levamisole	1	Not listed	0.003	
Piperazine	Not listed	Not listed	Not set	
Minor Use Permits Applied For				
	MRL (mg/kg)	**Codex MRL (mg/kg)**	**ADI mg/kgbodywt/day**	**Comment**
Amoxycillin♠	Not listed	Not listed	0.2	
Sulfadiazine	Not listed	Not listed	0.02	
Sulfadimidine	Not listed	Not listed	0.02	
Sulfaquinoxaline	Not listed	Not listed	0.01	
Toltrazuril♠	Not listed	Not listed	0.01	
Trimethoprim	Not listed	Not listed	0.02	

♠ **Note:** Currently subject to consideration by APVMA for a minor use permit. They can be used under veterinary supervision and subject to State Control-of Use laws.

Dimetridazole

As noted above, the APVMA has concluded its review of dimetridazole and has called for public comment prior to finalising the outcome. The toxicology assessment conducted as part of the review of dimetridazole concluded that there were significant deficiencies in the toxicological support base. As a result, the APVMA will accept the advice of the Office of Chemical Safety (OCS) that an acceptable daily intake (ADI) can no longer be supported to permit the continued use of dimetridazole in food producing animals. Nevertheless, the APVMA notes that it may be possible to allow the continued availability of dimetridazole products for the treatment of companion animals and birds.

Since an ADI for dimetridazole can no longer be supported, the registration of products currently used in food-producing animals will be cancelled. However, the APVMA has recognised that dimetridazole is an important tool in the management of blackhead in poultry and that there are no registered alternative chemicals available to treat outbreaks of this disease. The APVMA therefore intends to explore options to permit the limited use of dimetridazole in breeder stock.

The residue assessment notes that the use of dimetridazole in breeder chickens and breeder turkeys, while observing meat and egg withholding periods of 28 days, is expected to result in 'nil residue' levels. This would therefore not represent an undue risk to human health through dietary exposure. Furthermore, the use of dimetridazole with these limitations would not unduly prejudice Australia's export trade in poultry commodities. However, the APVMA must be satisfied that meat and eggs from treated breeder poultry can reliably be prevented from entering the food chain before the completion of the proposed withholding period.

Two regulatory options are proposed to support the ongoing use of dimetridazole; (i) use of the chemical be limited to companion animals only, with no use in any animal which may be consumed by humans, or (ii) use of dimetridazole in companion animals in addition to permitting limited use in non-food producing breeder poultry, breeder game birds, and breeder pigeons for squab production.

Assurance will be required from industry, user groups and registrants that the recommended withholding periods for breeding stock, and restraints on using the chemical in non-breeding stock, will be observed. The APVMA intends to liaise with stakeholders on this issue to determine whether dimetridazole use in breeding stock can be managed by the industry, specifically the observance of 28-day withholding periods for meat and eggs.

Summary
Pesticides and veterinary drugs registered for use in the egg industry were identified from the list of APVMA registered products. Products that were regarded to have generally wide acceptance within the egg industry were determined in consultation with the industry. From this, maximum residue limits (MRLs), Codex MRLs and Acceptable Daily Intake (ADI) figures, which apply to the active ingredients in those products were determined.

A number of chemicals identified as being 'in use' and of importance had no MRLs in place. In certain cases, there was also no ADI.

3. Possible Carryover of Pesticide Residues into Eggs

Despite regulatory requirements that the possibility of residue carryover into meat, milk and eggs must be addressed by registrants seeking approval of new products and uses, it is often difficult to predict whether residue carryover will occur under actual use conditions, and if so, which chemicals might be involved. The fact is that when pesticides are used, especially on possible components of animal feed, there is a potential for carryover of residues into meat, milk and eggs. Misuse or poor animal production practices can further add to that risk.

In recent times, food producers, particularly in the red meat industry, have been faced with pesticide residue detections and, in some cases violations against the established MRLs set in Australia or in export markets. This has led to significant trade disruption and at times, public disquiet about food safety. In some cases, circumstances arose that were not predicted during the assessment and registration process. These events have shown that the identification of pesticides that may give rise to residues in meat is far more problematic than in the case of veterinary drugs approved specifically for direct use in/on animals.

Pesticide residue violations that have resulted in trade disruption and food safety concerns within the red meat industry have mostly been due to unexpected (and often poor) practices such as the feeding of crop trash and other processing waste as well as the grazing of animals on land previously contaminated by persistent chemicals, the feeding of failed crops, particularly during times of drought, and most notably, the grazing of stock on pasture that has been contaminated by spray drift. The nature of the egg industry is such that many, though not all of these circumstances do not arise.

The registration requirements in Australia demand that product registrants must establish through animal transfer studies whether residues will carry over into meat, milk and eggs. If it is established that residues may carry over into these commodities, then appropriate MRLs are established. Consequently, pesticides that are used on crops that could be grazed or fed to animals under normal and accepted farming practices usually have, or should have, MRLs determined for meat, milk and eggs. Similarly, pesticides that are to be used in and around animal housing and farm structures, including poultry sheds, and which animals might come into contact also have MRLs set for animal commodities or are specifically exempted from the requirements of an MRL. Consequently there are a large number of pesticides, particularly insecticides, which have MRLs for meat, milk and eggs.

Given the number of pesticides and the multitude of uses, it is difficult to be certain of which pesticide or in what circumstances pesticide residues in eggs might arise. This uncertainty (which is experienced by most meat producing industries) can be further enhanced through illegal use or through use practices that change over time or are not approved and therefore not reflected in label instructions.

In the context of this study, the pesticides that may have the potential for carryover into eggs were selected from:

- pesticides used as grain protectants which may be used on stored grain that might be used in poultry feed,
- pesticides detected in the grains program of the National Residue Survey thereby indicating a potential risk of carryover,
- broad consideration of other pesticides, but in particular, those which are fat soluble.

3.1 Grain Protectants

There is a greater opportunity for pesticide residues in eggs arising from the feeding of cereal grain that has been treated in storage by grain protectant insecticides. However, the level of use of grain protectants in the central bulk handling systems averages only around 5-15% depending on seasonal conditions though the level of use in on-farm storages is unknown.

While individual bulk handling authorities may use different combinations of chemicals, current treatment regimes comprise an organophosphate (chlorpyrifos-methyl or fenitrothion) in combination with methoprene or until recently, chlorpyrifos-methyl or fenitrothion in combination with bioresmethrin. With the removal of bioresmethrin, consideration is being given to deltamethrin but introduction is likely to be delayed until MRLs are in place in overseas countries for wheat gluten and other cereal fractions. Pirimiphos methyl is used "on farm" but not by bulk handling authorities. Permethrin is not used but may have some future as a structural treatment. Carbaryl is only used as a structural treatment. Phenothrin is not used.

The grain protectants that are currently most widely used and therefore present a possible risk of carryover into eggs (and other animal products) are fenitrothion, chlorpyrifos-methyl, methoprene and deltamethrin (in anticipation of possible future use).

3.2 Pesticide Residues Identified in the National Residue Survey

Useful indicators of those pesticides which may carry over into eggs, are found in the results of the National Residue Survey's Grain Testing Program. As noted above, the NRS exists to give domestic and overseas consumers confidence in the safety of food produced in Australia and to facilitate exports of Australian agricultural products by demonstrating that they meet the requirements of importing countries. But important, and relevant to this study, is the fact that the commodity/chemical combinations for testing by the NRS are selected on the basis of risk assessment. In determining the risk, the NRS takes account of a number of factors, in particular:

- international and/or domestic perceptions of the commodity/chemical combination as a possible public health hazard;
- the toxicity of the chemical or its break-down products;
- the likelihood of residues occurring in the product (based upon potential for misuse, persistence in the crop, animal or environment, extent of use and use patterns);
- the extent and results of previous monitoring, and
- factors such as the availability and cost of suitable analytical methods.

The NRS analytical results for cereal grains (wheat, barley, sorghum, oats) consistently demonstrate across an extensive sampling regime that most commodities tested have no residues detected. However, over the past three years, pesticides with some frequency of detection in various animal fats and grain have included dieldrin and DDT arising from past use, chlorpyrifos, chlorpyrifos-methyl, dichlorvos, diazinon, fenitrothion, pirimiphos-methyl, methoprene, bioresmethrin, deltamethrin and piperonyl butoxide. In respect to grain protectants/fumigants, their purpose is for "protection" of grain in storage and therefore it must be expected that some level of residue will be present. At the same time, the NRS results show that residues detected above MRL are few, giving confidence in the residue status of cereal grains. However, the number of detections in grain adds to the sensitivity surrounding

the use of grain protectants on grain for animal feeding purposes though many of these pesticides also have widespread and important uses in other industries.

The ***pesticide*** residue detections and violations in cereal grains for the three NRS surveys over the period 1999-2003 are summarised in Table 13.2.

Table 13.2: Pesticide Detections and Violations – NRS Grains Program 1999-2003 (Wheat, Barley, Sorghum)

Chemical	No of Detections	No of Violations > MRL
Organophosphates		
Azamethiphos	8	8
Chlorpyrifos	10	3
Chlorpyrifos-methyl	3050	2
Dichlorvos	1127	19
Fenitrothion	2482	1
Pirimiphos-methyl	82	0
Malathion	7	0
Carbamates		
Carbaryl	9	0
Synthetic Pyrethroids		
Bioresmethrin	92	0
Deltamethrin	22	0
Insect Growth Regulators		
Methoprene	522	0
Synergists		
Piperonyl butoxide	110	0

These results suggest that the grain insecticides/protectants and grain fumigants with frequent NRS residue detections/violations (azamethiphos, chlorpyrifos-methyl, dichlorvos, fenitrothion, pirimiphos-methyl, deltamethrin, methoprene and the synergist piperonyl butoxide) should form the nucleus of those pesticides that have the potential to carryover from grain into eggs. The use of bioresmethrin on grain is now not permitted.

3.3 Other Pesticides

For the many other pesticides in use (such as those not included in the scope of NRS testing) there is no clear indicator as to which might carry over into eggs arising from use on commodities that form a portion of poultry diets. However, it would be appropriate to look at those pesticides that are fat-soluble and to consider them as potentially of higher risk. However, while fat-soluble chemicals may partition into egg yolk, water-soluble chemicals also have the potential to concentrate in the albumen.

A search of the NRA Residue Standard identified 60 chemicals where the MRL definition for meat was defined as “in the fat”. These pesticides are listed in Appendix B. This list was further analysed to identify those fat soluble pesticides that, on the basis of the commodities included in the APVMA MRL Standard have possible uses on a number of important animal feed components in particular, cereal grains (and processed grain fractions), oilseeds, lupins and pulses. The pesticides identified on this basis were bifenthrin, chlorpyrifos, chlorpyrifos-methyl, cyhalothrin, cypermethrin, deltamethrin, fenvalerate, fipronil, methoprene and spinosad. To make better judgements about the importance of the various pesticides, it would be helpful to have information on the extent of use of all pesticides, particularly the fat-soluble pesticides, but that information is not available.

3.4 Chemicals That Might Therefore Carryover into Eggs

Drawing together the pesticides selected from grain protectants/fumigants, chemicals with a high detection/violation rate in the NRS grains program and fat-soluble pesticides with uses on crops that may constitute components of poultry diets[5], the pesticides that might carryover into eggs are outlined in Table 13.3. Also included are endosulfan (on the basis of its persistence and recent residue incidents) and the organochlorine insecticides (dieldrin, aldrin, DDT, HCB and lindane) which, although not permitted for use, may still carryover through environmental contamination, particularly through residues in soil. Given the number of pesticide and use combinations, there can be no certainty that other pesticides may not at some time carryover into eggs.

A point to note about the pesticides that could carryover into eggs is that, with the exception of methoprene, MRLs for eggs have been established in all cases to accommodate that situation and that in most cases, the MRL is set at the limit of analytical quantitation indicating that finite residues through carryover are not expected. The MRLs for azamethiphos and piperonyl butoxide also cover their use in poultry sheds.

Table 13.3: Pesticides including grain protectants, pesticides included/detected in the NRS Grains Program and fat-soluble pesticides with possible use on feed commodities, which may carryover as residues into eggs via poultry feed.

Chemical	MRL (Eggs) mg/kg	Codex MRL mg/kg	ADI mg/kg/day	Chemical	MRL (Eggs) mg/kg	Codex MRL mg/kg	ADI mg/kg/day
Azamethiphos#	*0.05	Not set	0.003	Fenvalerate	0.02	Not set	0.02
Bifenthrin	*0.05	*0.01	0.01	Fipronil	T0.1	0.02	0.0002
Chlorpyrifos	T*0.01	0.01	0.003	Methoprene	None set	0.05	0.4
Chlorpyrifos methyl	*0.05	0.05	0.01	Piperonyl butoxide#	*0.01	1 ♠	0.1
Cyhalothrin	*0.02	Not set	0.02	Pirimiphos methyl	*0.05	To be withdrawn	0.02
Cypermethrin	0.05	0.05	0.05	Spinosad	T0.05	0.01	1
Deltamethrin	*0.01	*0.01	0.01	Aldrin & Dieldrin	E0.1	E0.1	0.0001 (T)
Dichlorvos	0.05	Not set	0.001	DDT	E0.5	0.1	0.002 (T)
Endosulfan	T*0.05	Not set	0.006	HCB	E1	Withdrawn	Not set
Fenitrothion	*0.05	Not set	0.002	Lindane	E0.1	E0.1	0.003

Notes:
T denotes that the MRL is temporary pending further data.
* indicates that the MRL is set at the limit of analytical quantitation ie no residues should be present.
# denotes that azamethiphos and piperonyl butoxide are also included in products for use in poultry sheds.
E denotes that the MRL is established to cover environmental contamination and not residues from approved uses.
♠ denotes that the MRL has been set to cover direct animal treatment.

[5] Mr Rowly Horn, Rowly Horn Services, provided advice on poultry diets and components of poultry feed.

Summary
Given the number of pesticides and the multitude of uses, it is difficult to be certain of which pesticide or in what circumstances pesticide residues in eggs may carryover from the feeding of treated feed or the environment. In the context of this study, the pesticides that may have the potential for carryover into eggs were selected from chemicals which may be used on stored grain, chemicals detected in the NRS grains monitoring program and from pesticides used on components of poultry diets and which are fat soluble. 21 pesticides with some degree of possible risk were identified. With the exception of methoprene, MRLs for eggs had been established in all cases to accommodate the possibility of residue carryover and in most cases, the MRL had been set at the limit of analytical quantitation indicating that finite residues through carryover were not expected.

4. The Actual Level of Residues - Monitoring Results for Residue Detection and Dietary Exposure

4.1 National Residue Survey – Residues in Raw Agricultural Commodities

During the period 1999/2000 to 2001/2002, 82 samples of eggs were analysed through the NRS for insecticide residues and 57 samples were analysed for metals. There were 304 samples analysed for antimicrobial chemicals. Each sample consisted of twelve homogenised eggs. No residues of pesticides or antimicrobials were detected and no metal residues were above Australian standards.

These results also confirmed the absence of residues of organochlorine insecticides (including DDT, aldrin, dieldrin, chlordane and heptachlor) arising from past use of these chemicals.

The NRS Egg Program has been temporarily discontinued while the industry and the NRS agree on the scope of a new monitoring program. The program would clearly benefit from inclusion of more recently introduced chemicals that are of current importance to the egg industry. This study may assist in identifying those chemicals.

Table 13.4: Combined National Residue Survey Results for Eggs (1999/2000-2001/2002)

Chemical	Matrix	LOR	MRL/ERL	Analysed	Residues	>MRL
Insecticides						
Aldrin	Whole	0.05	0.1	82	0	0
Chlordane	Whole	0.05	0.02	82	0	0
DDT	Whole	0.1	0.5	82	0	0
Dieldrin	Whole	0.01	0.1	82	0	0
Endosulfan	Whole	0.02	0.05	82	0	0
Endosulfan sulphate	Whole	0.02	0.05	82	0	0
Endrin	Whole	0.05	Not set	82	0	0
HCB	Whole	0.1	1	82	0	0
HCH	Whole	0.1	0.1	82	0	0
Heptachlor	Whole	0.05	0.05	82	0	0
Lindane	Whole	0.1	0.1	82	0	0
Methoxychlor	Whole	0.2	Not set	82	0	0
Mirex	Whole	1	Not set	82	0	0
Toxaphene	Whole	1	Not set	82	0	0
Organophosphates						
Bromophos ethyl	Whole	0.1	Not set	82	0	0
Chlorpyrifos	Whole	0.01	0.01	82	0	0
Diazinon	Whole	0.05	0.05	82	0	0
Dichlorvos	Whole	0.05	0.05	82	0	0
Ethion	Whole	0.05	Not set	82	0	0
Fenchlorphos	Whole	0.05	0.05	82	0	0
Malathion	Whole	0.1	1	82	0	0
Antimicrobials						
Amoxycillin	Whole	0.01	Not set	304	0	0
Ampicillin	Whole	0.01	Not set	304	0	0
Benzyl Penicillin	Whole	0.01	0.018	304	0	0

Chlortetracycline	Whole	0.05	Not set	304	0	0
Cloxacillin	Whole	0.01	Not set	304	0	0
Dihydrostreptomycin	Whole	0.1	0.2	304	0	0
Erythromycin	Whole	0.1	0.3	304	0	0
Lincomycin	Whole	0.05	0.2	304	0	0
Neomycin	Whole	0.25	Not set	304	0	0
Oxytetracycline	Whole	0.05	0.3	304	0	0
Streptomycin	Whole	0.1	0.2	304	0	0
Tetracycline	Whole	0.05	Not set	304	0	0
Tilmicosin	Whole	0.2	Not set	304	0	0
Tylosin	Whole	0.1	0.2	304	0	0
Metals						
Cadmium	Whole		Not set	57	1	0
Lead	Whole		Not set	27	5	0
Mercury	Whole		Not set	57	3	0

4.2 The Australian Total Diet Survey – Residues in the Diet

FSANZ monitors the food supply to ensure that existing food regulatory measures provide adequate protection of consumer health and safety. The Australian Total Diet Survey (ATDS) is part of that monitoring.

The Australian Total Diet Survey, formerly known as the Australian Market Basket Survey, is Australia's most comprehensive assessment of consumers' dietary exposure (intake) to pesticide residues, contaminants and other substances. The survey is conducted approximately every two years.

The survey estimates the level of dietary exposure of the Australian population to a range of pesticide residues, contaminants and other substances through the testing of food samples representative of the total diet. In order to achieve more accurate dietary exposure estimates, the foods examined in the ATDS are prepared to a 'table ready' state before they are analysed. As a consequence, both raw and cooked foods are examined.

FSANZ coordinate the survey while the States and Northern Territory purchase and prepare the food samples. The Australian Government Analytical Laboratories (AGAL) perform all analyses.

The survey also provides valuable background data that can be used for the development of food regulatory measures. Data from previous surveys were used by the Australia New Zealand Food Authority (ANZFA) during the Review of the *Food Standards Code* and were integral to the development of standards in Volume 2 of the *Australia New Zealand Food Standards Code*. The survey is also used by the Australian Pesticides and Veterinary Medicines Authority when considering registration of chemical products.

Unlike the National Residue Survey, the ATDS is a *direct* measure of food and consumer safety as it estimates *actual* levels of dietary intake of chemical residues and for individual chemicals, allows comparisons to be made against a public health standard, viz the acceptable daily intake (ADI).

The 20th ATDS, conducted between July 2000 and April 2001, confirmed the overall safety of the Australian food supply and demonstrated that pesticide residues, metals, and selected antibiotics, aflatoxins and ochratoxins were either absent or present in low amounts.

4.2.1 Pesticides Included in the Survey

The range of pesticide residues tested in the Survey were:

- organochlorine insecticides (arising from past use)
- organophosphorus insecticides
- synthetic pyrethroids
- fungicides including chlorothalonil, dicloran, dophenylamine, porcymidone and vinclozolin
- some carbamates
- a range of other individual pesticides

The only pesticide detected in eggs and egg products was p,p' and o,p' DDE indicative of past use of DDT. It was detected in only one of 28 samples. Overall mean results for p,p' and o,p' DDE in eggs was 0.001 mg/kg with the maximum level reported at 0.016 mg/kg. These results were of no food safety concern.

The detected pesticide residues for which dietary exposure for all age groups was less than 0.2% of the ADI were acephate, azinphos-methyl, bifenthrin, captan, chlorfenvinphos, chlorothalonil, total DDT, dimethoate, endosulfan, fenoxycarb, fenthion, maldison, metalaxyl, methidathion, methoprene, 0-phenylphenol, permethrin, pirimicarb, pirimiphos-methyl, propiconazole, pyrimethanil and tetradifon.

The mean estimated daily dietary exposure to pesticide residues as a percentage of the ADI based on mean analytical results is outlined in Table 13.5. The results demonstrate that there were no pesticides, including those of interest to the egg industry, that present any public health concern in respect to the dietary intake of residues.

Table 13.5: Mean estimated daily dietary exposure to pesticide residues as a percentage of the ADI based on mean analytical results. (Extracted from the report of the 20th Australian Total Diet Survey, FSANZ 2003)

Chemical	Adult males (25-34 years) %TDI	Adult females (25-34 years) %TDI	Boys (12 years) %TDI	Girls (12 years) %TDI	Toddler (2 years) %TDI	Infant (9 months) %TDI
Acephate	0.09	0.09	0.11	0.10	0.11	0.08
Azinphos-methyl	0.04	0.06	0.04	0.05	0.20	0.15
Bifenthrin	0.03	0.03	0.03	0.03	0.06	0.03
Bioresmethrin	<0.01	<0.01	0.01	<0.01	0.01	<0.01
Captan	<0.01	0.01	<0.01	0.01	0.06	0.04
Carbaryl	0.85	1.20	1.24	1.35	5.27	3.79
Chlorfenvinphos	0.05	0.05	0.06	0.06	0.07	0.05
Chlorothalonil	0.03	0.05	0.04	0.03	0.07	0.05
Chlorpyrifos	0.17	0.20	0.37	0.31	0.71	0.51
Chlorpyrifos-methyl	0.72	0.63	1.29	0.89	1.82	1.29
DDT (total)[8]	0.03	0.02	0.02	0.02	0.05	0.04
Dimethoate	<0.01	<0.01	<0.01	<0.01	0.02	0.01
Diphenylamine	0.15	0.17	0.52	0.35	1.01	0.72
Endosulfan	0.04	0.04	0.07	0.03	0.05	0.04
Fenitrothion	0.54	0.48	0.87	0.63	1.30	0.91
Fenoxycarb	<0.01	<0.01	0.02	0.01	0.03	0.02
Fenthion	0.11	0.11	0.13	0.12	0.17	0.12
Iprodione	1.19	0.62	0.39	0.34	1.12	0.82
Maldison	<0.01	<0.01	<0.01	<0.01	0.02	0.02
Metalaxyl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Methamidophos	13.11	12.28	15.49	13.76	15.68	5.72
Methidathion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Methoprene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
o-phenylphenol	<0.01	<0.01	0.02	0.01	0.05	0.03
Parathion-methyl	1.30	1.68	3.25	2.37	7.44	5.44
Permethrin	0.03	0.03	0.04	0.03	0.04	0.03
Piperonyl butoxide	0.07	0.07	0.13	0.09	0.22	0.15
Pirimicarb	0.01	0.02	0.05	0.03	0.09	0.07
Pirimiphos-methyl	0.06	0.05	0.11	0.06	0.15	0.01
Procymidone	0.15	0.19	0.22	0.14	0.40	0.30
Propargite	2.47	3.10	6.61	4.75	14.90	10.78
Propiconazole	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Pyrimethanil	<0.01	0.01	0.01	0.02	0.06	0.04
Tebufenpyrad	0.18	0.23	0.44	0.33	1.06	0.77
Tetradifon	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vinclozolin	2.75	2.73	2.31	2.17	9.73	7.06

Chemicals that were included in the scope of the ATDS and were **not** detected in any foods, including eggs, are included in Table 13.6. Those pesticides that have important uses in the egg industry (Table 13.1) or have been identified as having the potential to carryover into eggs through feed (Table 13.3) that were not detected in the ATDS (identified by *) include cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, fenvalerate, aldrin, lindane, dieldrin and heptachlor.

Table 13.6: Chemicals Not Detected in Any Food as Determined by the 20th Australian Total Dietary Study.

Carbamates Aldicarb	**Organophosphorus Pesticides** Azinphos ethyl Bromophos-ethyl Carbophenothion Coumaphos Demeton-S-methyl Diazinon Dichlorvos Dioxathion Ethion Fenamiphos Fenchlorphos Formothion Methacrifos Mevinphos Monocrotophos Omethoate Parathion Phorate Phosalone Phosmet Thiometon Trichlorfon Vamidothion	**Aflatoxins** Aflatoxin B1 Aflatoxin B2 Aflatoxin G1 Aflatoxin G2
Fungicides Bupirimate Dicloran Difenoconazole Dimethomorph Flusilazole Hexaconazole Imazalil Myclobutanil Tebuconazole Triadimefon Triadimenol	**Synthetic pyrethroids** Cyfluthrin * Cyhalothrin * Cypermethrin * Deltamethrin * Fenvalerate (& Esfenvalerate) * Flumethrin	**Ochratoxins** Ochratoxin A
Chlorinated Organic Pesticides Aldrin * BHC (total: Lindane * Chlordane Dicofol Dieldrin * Endrin Heptachlor * Hexachlorobenzene	**Other** Coumatetralyl Oxyfluorfen Pendimethalin	**Inhibitory Substances** Oxytetracycline Penicillin G Streptomycin

4.2.2 Inhibitory Substances Included in the Survey

A range of foods including eggs were tested for inhibitory substances viz penicillin G, streptomycin and oxytetracycline. These inhibitory substances were not detected in any food.

4.2.3 Heavy Metal Contaminants Included in the Survey

The 20th ATDS also monitored for heavy metals in foods, including eggs. The results for eggs are outlined in Table 13.7. No egg samples had heavy metal residues of any food safety consequence.

Table 13.7: Heavy Metal Residues in Eggs – Extracted from 20th Australian Total Diet Study

Metal	No of Samples	No nd Samples	Mean Nd=0 mg/kg	Mean Nd=LOR mg/kg	Median mg/kg	Minimum mg/kg	Maximum mg/kg
Antimony	28	28	---------- No Detections ----------				
Arsenic	28	2	0.022	0.023	0.02	nd	0.04
Cadmium	28	28	---------- No Detections ----------				
Copper	28	0	0.641		0.65	0.53	0.82
Lead	28	26	0.001	0.010	nd	nd	0.01
Mercury	28	28	---------- No Detections ----------				
Selenium	28	0	0.284	0.284	0.27	0.18	0.47
Tin	28	0		12.1	12	6.6	21

Nd – Not Detected LOR – Limit of Resolution

The range of mean estimated daily dietary exposures to metals for all foods and expressed as a percentage of the tolerable limit based on median analytical results is outlined in Table 13.8.

Table 13.8: Range of mean estimated daily dietary exposures to metals for all foods expressed as a percentage of the tolerable limit based on median analytical results. (20th Australian Total Diet Study)

Metal	Adult males (25-34 years) %TDI	Adult females (25-34 years) %TDI	Boys (12 years) %TDI	Girls (12 years) %TDI	Toddler (2 years) %TDI	Infant (9 months) %TDI
Antimony	3.1-21	1.8-18	2.3-23	1.9-18	3.6-48	2.7-61
Arsenic	18.6-29.2	16.2-25.9	16.6-27.5	9.4-18.0	18-44	12-48
Cadmium	7.6-24	6.9-22	11-29	8.9-22	18-57	13-68
Copper	8.0	7.2	11	8.2	20	32
Lead	1.8-11	0.67-9.9	0.45-12	0.27-9.5	0.72-26.0	0.35-33.3
Mercury	1.9-13	2.1-12	1.9-14	1.4-11	1.9-28	1.4-35
Selenium	9.3-11	7.7-9.5	12-13	9.1-10	21-24	17-19
Tin	0.06-0.08	0.08-0.09	0.08-0.10	0.03-0.05	0.59-0.63	0.43-0.45
Zinc	17	13	25	17	37	63

The report of the 20th ATDS recommended that:

1. method development be undertaken to achieve lower LORs for antimony, arsenic, cadmium, lead and mercury. This would allow a more accurate and refined estimate of dietary exposure to be presented in future total diet surveys;

2. in future surveys, tin analyses be focused on canned foods;

3. analyses of antimony, arsenic, cadmium, copper, lead, mercury, selenium and zinc, continue to be undertaken in future surveys so that dietary exposure assessments can be undertaken for these substances;

4. future surveys should continue to monitor aflatoxins and ochratoxins but this should be targeted to specific foods where these toxins are more likely to be found;

5. pesticide residues should continue to be monitored to determine dietary exposure to pesticide residues. Over a number of surveys, a large amount of data relating to pesticide residues has been collected, with the estimated dietary exposures to pesticide residues being well below that of the respective health standards (ADIs). As a consequence, it is recommended that monitoring of pesticide residues be undertaken at a lower frequency in future surveys;

6. monitoring of pesticide residues in future total diet surveys should focus on those chemicals for which there are no recent data and should not be limited to those chemicals registered for use in Australia.

Recommendations 5 and 6 are of particular interest in that they reflect the fact that over many years, pesticide residues in food have not been of dietary intake concern. However, FSANZ has correctly identified the need to obtain data for chemicals that have not been included in the scope of past surveys, possibly including more modern chemicals.

Summary
To determine the level of residues in eggs and their significance in terms of food safety, the results from the National Residue Survey (NRS) over the past 3 years were reviewed. During the period 1999/2000 to 2001/2002, 82 samples of eggs were analysed through the NRS for insecticide residues and 57 samples were analysed for metals. There were 304 samples analysed for antimicrobial chemicals. No residues of pesticides or antimicrobials were detected in eggs and no metal residues were above Australian standards. These results also confirmed the absence of residues of organochlorine insecticides (including DDT, aldrin, dieldrin, chlordane and heptachlor) arising from past use of these chemicals. The NRS Egg Program has since been temporarily discontinued.

The Australian Total Diet Survey (ATDS) was also reviewed. Unlike the National Residue Survey, the ATDS is a *direct* measure of food and consumer safety as it estimates actual levels of dietary intake of chemical residues and for individual chemicals, allows comparisons to be made against a public health standard, viz the acceptable daily intake.

The 20th ATDS, conducted between July 2000 and April 2001, confirmed the overall safety of the Australian food supply and demonstrated that in eggs (as with all foods) pesticide residues, metals, and selected antibiotics, aflatoxins and ochratoxins were either absent or present in low amounts. A number of chemicals included in the survey and considered of importance to the egg industry were not detected at any level.

5. Dioxins and Polychlorinated Biphenyls (PCBs)

The Australian Egg Corporation Limited has asked that the risk profile consider dioxins in conjunction with the chemicals (veterinary drugs and pesticides) that might pose a public health risk. The first point to stress is that there are no pesticides or veterinary drugs approved in Australia that contain dioxins as impurities of manufacture. Also, as dioxins are contaminants, it is not usual practice by regulatory authorities to set MRLs, however maximum levels, (as against maximum residue limits), for dioxins in food commodities have been set by some countries but not yet by Australia.

Dioxin is a generic term for a family of chemicals with related properties and toxicity. There are over 75 different dioxins or polychlorinated dibenzodioxins (PCDDs), 135 different furans or polychlorinated dibenzofurans (PCDFs) and 209 different polychlorinated biphenyls (PCBs). Each different form is called a "congener".

Because of their persistence in the environment 'dioxins' may be absorbed into the body fat of animals and humans. Human exposure may result in serious health conditions including skin disorders, reproductive effects and cancer. However, not all of the "dioxin-like" chemicals have dioxin-like toxicity and the toxic ones are not equally toxic. Only 7 of the 75 dioxins, 10 of the 135 furans and 12 of the 209 PCBs have dioxin-like toxicity. These 29 different dioxins, furans and PCBs all exhibit similar toxic effects caused by a similar mechanism. The most potent member of this family is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD. TCDD was an impurity of manufacture in the herbicide 2,4,5-T that was used in Vietnam as a component of Agent Orange.

The word 'dioxin' is often used imprecisely. Some restrict its use to only 2,3,7,8-TCDD, the most toxic and widely studied dioxin. Others extend its use to the whole class of chemicals with similar toxicity.

Toxic Equivalents (TEQ)

As noted above, not all dioxin-like compounds are equally toxic. Their different toxicities may be due to their unique properties of absorption, distribution, metabolism and elimination in the body. Therefore, rating their toxicities relative to TCDD, the most potent of the dioxins, assesses the health risk of each congener. TCDD is assigned the value of "1" and each of the 17 toxic dioxins/furans and the 12 PCBs is assigned a "toxicity factor" that estimates its toxicity relative to TCDD. The resulting estimates are termed toxic equivalency factors (TEFs).

The toxic equivalency (TEQ) is determined by multiplying the concentration of a dioxin congener by its toxicity equivalency factor. Adding all of the TEQ value results for each congener then derives the total TEQ in a sample. While TCDD is the most toxic form, 90% of the total TEQ value results from dioxin-like compounds other than TCDD. As the public equate dioxin with TCDD, it is important that reference to dioxin be in the correct context to avoid misunderstanding and unnecessary concern.

While the TEQ system is not perfect, it is a reasonable way of estimating the toxicity of a mixture of dioxin-like compounds. There are also good reasons to support the assumptions and the approach has now gained international acceptance.

In 1999, dioxin contamination of food products in Europe (Belgium, France and The Netherlands) resulted in extensive food product recalls that extended to poultry, egg, pork, beef and dairy products. The source of the contamination was determined to be animal feed and in particular, contaminated fat used in feed pellet production. The ramifications were

extensive and in Australia food products were recalled including processed foods such as pates, butter, biscuits, pastries and sauces.

5.1 The National Dioxins Program

In the 2001-2002 Federal Budget, the Commonwealth Government announced funding for a National Dioxins Program to be conducted over four years by the Department of Environment and Heritage. The program will provide a better understanding of the sources and possible levels of dioxins in the Australian environment and diet. The Program will also lead to information that will assist Australia meet obligations under the Stockholm Convention relating to Persistent Organic Pollutants (POPs). The program is being implemented in three stages:

> Stage 1. Government agencies are undertaking monitoring programs to determine if dioxins and related compounds are present in the environment and in certain agricultural commodities.
>
> Stage 2. Potential risks to human health and the environment are to be assessed once the level of possible exposure has been determined.
>
> Stage 3. National management strategies will be developed to reduce and, where appropriate, eliminate the release of dioxins in Australia.

As part of the overall National Dioxins Program, the Department of Health and Ageing was asked to establish a tolerable weekly intake for dioxins and related compounds to be endorsed by the National Health and Medical Research Council (NH&MRC) as a basis for national acceptance. The NH&MRC endorsed the Department of Health's proposal that Australia establish a Tolerable Monthly Intake (TMI) for dioxins of 70 pg TEQ/kg bodyweight from all sources combined. This tolerable intake is equal to that set by the WHO/FAO Joint Expert Committee on Food Additives (JECFA), and includes polychlorinated dioxins, polychlorinated furans and dioxin-like PCBs as specified under the WHO 1998 TEF scheme. The setting of a TMI will allow for dioxin standards to be developed. At the present time there are no dioxin food standards set by FSANZ. However, FSANZ may move to set standards for dioxins in the light of the results of the National Dioxins Program. The FSANZ standard for polychlorinated biphenyls (total) in eggs is 0.2 mg/kg.

5.2 Levels of Dioxin Contamination in Eggs and Other Agricultural Commodities

Stage 2 of the National Dioxins Program was recently concluded with the reporting of levels of dioxins in components of the environment as well as in food. Of particular importance was the study "Dioxins in Food – Dietary Exposure Assessment and Risk Characterisation" conducted by Food Standards Australia New Zealand (FSANZ). The dioxin and PCB levels found in eggs were as follows:

Table 13.9: Mean levels of PCDD/F (dioxins/furans) and PCBs in eggs (Extracted from 'Dioxins in Food – Dietary Exposure Assessment and Risk Characterisation, Technical Report Series No 20, FSANZ 2004)

Food	Number of Samples	PCDD/F		PCB	
		Lowerbound pg/g FW	Upperbound pg/g FW	Lowerbound pg/g FW	Upperbound pg/g FW
Eggs	13	0.0026	0.045	0.0062	0.012

FW = Fresh Weight

Note: All results are reported in picograms TEQ per gram of food on a fresh weight basis
Lower bound results assume results reported as below the limit of reporting (LOR) are zero for each congener. The levels of the individual congeners are then summed
Upper bound results assume results reported as below the limit of reporting (LOR) are at the LOR for each congener. The levels of the individual congeners are then summed.

The study also reported comparisons of mean PCDD/F and PCB concentrations in selected foods from different areas of the world.

Table 13.10: Comparisons of mean PCDD/F concentrations in selected foods from different areas of the world

	Mean PCDD/F (pg TEQ/g lipid)						
	Australia This study	**New Zealand**	**UK**	**Netherlands**	**Europe***	**Asia***	**North America***
Eggs	**0.013-0.42**	**0.017-0.12**	**0.24-0.24**	**1.52**	**0.5-2.7**	**-**	**0.044-0.3**
Beef	0.0006-0.24	0-0.11	0.41-0.42	0.82	0.6-1	1.0	0.5-4.1
Pork	0.05-0.22	0-0.20	-	0.24	0.2-1.4	0.8	0.6-23
Lamb	0.004-0.25	0-0.07	-	-	-	-	-
Poultry	0.02-0.53	0.037-0.29	0.13-0.18	1.06	0.6-0.9	0.67	0.03-3.9
Fish	1.56-3.04	0.33-0.41	1.06-1.06	0.181	0.01-8.9	0.002-10.2	0.033-0.53
Milk	0.04-0.23	0.019-0.16	0.46-0.47	0.57	0.3-2.5	0.30-1.8	0.3-0.9

See FSANZ Report for full details of comparisons

* Results as reported in Position Paper on Dioxins and Dioxin-like PCBs (CX/FAC 03/32), Codex Committee on Food Additives and Contaminants, 35th Session, March 2003

Table 13.11: Comparisons of mean PCB concentrations in selected foods from different areas of the world

	Mean PCBs (pg TEQ/g lipid)						
	Australia This study	**New Zealand**	**UK**	**Netherlands**	**Europe***	**Asia***	**North America***
Eggs	**0.04-0.11**	**0.05-0.11**	**0.11-0.20**	**0.87**	**0.2-0.6**	**-**	**0.029**
Beef	0.03-0.11	0.0036-0.092	0.25-0.31	1.24	-	-	0.5
Pork	0.04-0.07	0.15-0.43	-	0.23	0.8	-	0.02-1.7
Lamb	0.02-0.06	0.01-0.045	-				
Poultry	0.18-0.24	0.018-0.14	0.47-0.53	1.72	0.7	-	0.3
Fish	9.46-9.5	0.77	3.57-3.57	0.412	0.03-9	0.004-2.0	0.11-0.28
Milk	0.04-0.11	0.027-0.15	0.34-0.43	0.69	0.2-1.8	-	0.5

See FSANZ Report for full details of comparisons

* Results as reported in Position Paper on Dioxins and Dioxin-like PCBs (CX/FAC 03/32), Codex Committee on Food Additives and Contaminants, 35th Session, March 2003

The results demonstrate that dioxin and PCB levels in Australian eggs are less than that reported in overseas studies.

While FSANZ is yet to establish any food standards in respect to dioxins, maximum levels for dioxins in food commodities have been set in some overseas countries. These are reported by the Department of Health and Ageing in "Dioxins: Recommendations for a Tolerable Monthly Intake for Australians, October, 2002" as follows:

Country	**Maximum or Provisional Maximum Levels (pg WHO-TEQ/g fat)**
Austria	2 pork, 3 milk, 5 poultry/**eggs**, 6 beef
Belgium	3 pork and derived products, 5 milk, bovine, poultry, animal fats and oils, **eggs**, and derived products (if >2% fat)
France	5 milk and dairy products
Germany	< 0.9 milk and dairy products * **
Luxemburg	2 pork, 3 milk, 5 poultry/**eggs**, 6 beef
The Netherlands	6 dairy products and foods with milk or dairy products as ingredients
Spain	> 5 dairy products

Source: Department of Health and Ageing "Dioxins: Recommendation for a Tolerable Monthly Intake for Australians, October, 2002" and taken form the Codex Alimentarius (CAC), Codex Committee on Food Additives and Contaminants (CCFAC), 33rd Session, 12-16 March, 2001

* This is a proposed desirable target level. Trade would be prohibited at levels above 5 pg1-TEQ/g fat.

** pg 1-TEQ/g fat for PCDDs and PCDF's

Present regulation in regard to maximum levels for dioxins in *food* in Codex member countries has also been documented by CCFAC at its 35th meeting in March 2003. The only reference from that source is again the Council of the European Union which, in Council Directive 2375/2001 of 29 November 2001, defined the following levels. They have applied

in the EU since 1 July 2002 and are to be reviewed by 31 December, 2004 with a view to including dioxin-like PCBs in the levels to be set.

Table 13.12: Maximum Dioxin Levels in Food (Applying in the EU since 1 July, 2002)

Product	Maximum Level (1) (3)
Hen eggs and egg products (2)	**3 pg WHO-PCDD/F-TEQ/g fat**
Meat and Meat Products Originating From:	
- ruminants (bovine animals, sheep)	3 pg WHO-PCDD/F-TEQ/g fat
- poultry and farmed game	2 pg WHO-PCDD/F-TEQ/g fat
- pigs	1 pg WHO-PCDD/F-TEQ/g fat
Liver and derived products	6 pg WHO-PCDD/F-TEQ/g fat
Muscle meat of fish and fishery products and products thereof	4 pg WHO-PCDD/F-TEQ/g fresh weight
Milk and milk products, including butter fat	3 pg WHO-PCDD/F-TEQ/g fat
Oils and Fats:	
Animal fat from:	
- ruminants	3 pg WHO-PCDD/F-TEQ/g fat
- poultry and farmed game	2 pg WHO-PCDD/F-TEQ/g fat
- pigs	1 pg WHO-PCDD/F-TEQ/g fat
- mixed animal fat	2 pg WHO-PCDD/F-TEQ/g fat
Vegetable oil	0.75 pg WHO-PCDD/F-TEQ/g fat
Fish oil intended for human consumption	2 pg WHO-PCDD/F-TEQ/g fat

(1) Upperbound concentrations
(2) Free range or semi-intensive eggs must comply with the maximum level laid down as from 1 January, 2004
(3) The MLs are not applicable for food products containing < 1% fat

5.3 Dietary Exposure to Dioxins and PCBs Through Residues in Food

Based on the dioxin concentration data for all foods analysed as part of the National Dioxins Program, FSANZ also undertook a dietary exposure assessment using dietary modeling techniques that combine food consumption data with food chemical concentration data to estimate the exposure to the food from the diet.

Dietary exposure = food chemical concentration x food consumption.

Exposures to dioxins and PCBs were calculated separately to PCBs for each population group, expressed as picograms TEQ per kilogram of bodyweight per month. The exposure to dioxins from all foods for each population was then determined by summing the separate dioxin and PCB exposures.

The percentage contribution of major food contributors to dioxin and PCB dietary exposure for the 2-4 years age group and the whole population were as follows:

Table 13.13: Percent contribution of major food contributors to dioxin and PCB dietary exposure for toddlers (2-4 years) and the whole population 2+ years

	PCDD/F		PCBs	
	Toddlers 2-4 yrs	**Whole population 2+**	**Toddlers 2-4**	**Whole population 2+**
Eggs		**2**		
Bacon & Pork	2	7		2
Beef, veal & game		2	2	3
Poultry			2	2
Sausages			3	2
Cereal Products	5	4	2	
Peanut butter	8	4		
Butter		2		
Vegetables	2	3		
Fruit & Fruit Juice			2	
Milk chocolate	2			
Milk & Dairy	55	31	30	11
Fish, crustacea & molluscs	18	39	49	72
Canned Fish				2
All other foods	8	6	10	6

Eggs contributed 2% of the dietary exposure to dioxins for the whole population. No specific measure of egg contribution to the dietary intake of PCBs was reported.

5.3.1 Consumer Risk

In respect to the dioxin results, FSANZ concluded, "*a simple comparison of the dietary exposure data in foods with the Australian Tolerable Monthly Intake (TMI) does not raise any public health concerns as the results are all below the TMI. While exposure to dioxins in foods varies with age, any potential risk from dioxins is long-term and related to lifetime body burden rather that to short-term dietary exposure. Thus the overall risk to Australian consumers following the consumption of foods containing dioxins is considered to be very low for individuals in all age groups."*

While noting that there are no immediate areas of public health concern, the Department of Health and Ageing has noted the need to reduce, where possible, the emission of dioxin-like compounds to the environment[6]. The Department recommends *inter-alia* that ways to block the cycling of dioxins through the food supply need to be identified. Specifically, the Department recommends, "*reducing the levels of dioxins in feed given to livestock, poultry and aquaculture fish will help to reduce the levels of dioxins in the food supply. This may be achieved by reducing the amount of animal fat used as a growth enhancer in stockfeed and sourcing fish-based aquaculture feed (eg pilchards, sardines) from non-polluted environments*."

[6] National Dioxins Program Technical Report No 12, "Human Health Risk Assessment of Dioxins in Australia" prepared for the Department of the Environment and Heritage by the Office of Chemical Safety, Department of Health and Ageing.

5.4 Sources of Dioxin and PCB Contamination

Sources of dioxin emissions include motor vehicles, bushfires, waste burning and accidental fires, as well as certain industrial manufacturing processes. Subsequently, dioxins may find their way into air, soils and aquatic environments as well as into fauna, food and the human body.

In terms of possible dioxin contamination of eggs, the feeding of crops that may have been contaminated by dioxins through air and soil (dust) might be a potential risk as also might be free-range egg production where chickens are more exposed to the open environment, particularly soil. The extent is unknown but based on the overall results of dioxin analysis of foods it would seem minimal.

Animal feed contamination through anti-caking agents and fishmeal stocks have been reported overseas as leading to dioxin contamination (Report of the Codex Committee on Food Additives and Contaminants [CCFAC], 35th Session, 17-21 March, 2003). Prevention of contamination through the addition of these types of additives to feed therefore seems to be a matter of quality assurance that is dependant on environmental "hot spots" associated with the surrounding level of industrialisation. The level of quality assurance measures required in Australia, if any, may be the subject of consideration under Part 3 of the National Dioxins Program viz the development of measures to reduce, and where feasible, to eliminate the release of dioxins in Australia.

Current regulations in regard to maximum levels for dioxins in animal *feed* in Codex member countries have been documented by the Codex Committee on Food Additives and Contaminants CCFAC (35th Session). The only reference to regulation in that report is the Council of the European Union which, in Council Directive 2001/102/ EC of 27 November, 2001 defined the following levels. They have applied in the EU since 1 July, 2002 and are to be reviewed by 31 December, 2004 with a view to including dioxin-like PCBs in the levels to be set.

Table 13.14: Maximum Levels of Dioxins in Feed in the EU (Applying in the EU since 1 July, 2002)

Product	**Maximum Level** (1)
All feed materials of plant origin including vegetable oils and by-products	0.75 ng WHO-PCDD/F-TEQ/kg
Minerals	1.0 ng WHO-PCDD/F-TEQ/kg
Animal fat, including milk fat and **egg fat**	2.0 ng WHO-PCDD/F-TEQ/kg
Other land animal products including milk and milk products and **eggs** and **egg products**	0.75 ng WHO-PCDD/F-TEQ/kg
Fish oil	6 ng WHO-PCDD/F-TEQ/kg
Fish, other aquatic animals, their products and by-products with the exception of fish oil	1.25 ng WHO-PCDD/F-TEQ/kg
Compound feedingstuffs, with the exception of feedingstuffs for fur animals and feedingstuffs for fish	0.75 ng WHO-PCDD/F-TEQ/kg
Feedingstuffs for fish	2.25 ng WHO-PCDD/F-TEQ/kg

(1) Upperbound concentrations

5.5 International Trends

The USA and countries in the EU report that over the past 10 - 30 years there has been a steady decline in dioxin and PCB levels in food. The UK 2001 Total Diet Study reports that estimated average intakes of dioxins and dioxin-like PCBs by all ages fell by around 50% between 1997 and 2001.

For most countries in the EU, the main contributors to the average daily intake of dioxins are milk and dairy products (contribution ranged from 16-39%), and meat and meat products (6-32%). Fish is prominent in the average intake in several countries including Italy, Norway and Finland.

Several industrialised countries in Asia report estimates of dietary intake. In Taiwan, Korea, and Japan, foods contributing to dioxin and PCB levels were fish and shellfish.

The Codex Committee on Food Additives and Contaminants (CCFAC) has noted that in respect to Europe, eggs are characterised by a rather consistent PCDD and PCDF presence while data from the USA and Canada are comparable, assuming a fat content of 10% for eggs. CCFAC also notes that the concentration of dioxins in pooled Dutch samples of eggs dropped from 2.0 pg I-TEQ/g fat in 1991 down to 1.2 pg I-TEQ/g fat in 1999, and from 2.3 pg WHO-TEQ/g fat down to 0.6 pg WHO-TEQ/g fat in 1999 for dioxin-like PCBs.

Table 13.15: Results of Dioxin Monitoring in Eggs. (CCFAC, 35th Session, March, 2003)

Eggs	PCDD and PCDF pg TEQ/g fat	Dioxin-like PCBs pg WHO-TEQ/g fat	Dioxins and dioxin-like PCBs pg TEQ/g fat
Europe	0.5-2.7	0.2-0.6	None reported
North America	0.044-0.3 [1]	0.029 [1]	None reported
South America			None reported
Asia	0.8		None reported
Australia-New Zealand	0.12 [2]	0.11 [2]	None reported
Africa			None reported

(1) pg per gram product
(2) New Zealand results from 1995 monitoring program of meat, dairy products and high fat foods.

CCFAC also reports that in a study in The Netherlands of eggs from free-range chickens, increased concentrations of WHO-TEQ were found in eggs from organic farms in 2001. Levels of dioxins in four samples (out of eight) were above the EU standard of 3 pg WHO-TEQ/g fat up to 8.2 pg. Levels of dioxin-like PCBs in these samples were up to 5.1 pg WHO-TEQ/g fat. Dioxin levels in eggs of (non organic) free-range farms were not increased. A similar situation was reported for Belgium where eggs from free-range (non organic) farms contained dioxin levels that were equal to those of conventional chicken farms. In a similar UK study, eggs from poultry reared on allotments, high levels of dioxins were detected due to exposure to incinerator ash. After removal of the ashes the dioxin levels declined from 16 pg I-TEQ to 9 pg I-TEQ/g lipid, but still remained above the known background levels of dioxins in eggs.

The Codex Committee on Food Additives and Contaminants is expected to establish international dioxin and PCB standards for individual foods in the near future. The results of the Australian National Dioxins Program will be critical to Australia's input into that debate. However, despite nearly 10 years of study, it is understood that the USA continues to debate the setting of appropriate standards for dioxins and PCBs in foods. Despite extensive

assessment by regulatory agencies, the US National Academy of Sciences has said that there is insufficient data to make any formal regulatory recommendations to reduce human exposure to dioxins in meat, milk and eggs. It would seem unlikely that the US would agree to any international Codex standards for levels of dioxins in food being established in advance of their domestic position being resolved.

Summary
Stage 2 of the National Dioxins Program recently concluded with the reporting of levels of dioxins in components of the environment as well as in food. The results demonstrated that dioxin and PCB levels in Australian eggs were less than that reported in overseas studies. Eggs contributed 2% of the dietary exposure to dioxins for the whole population. No specific measure of egg contribution to the dietary intake of PCBs was reported. FSANZ concluded that a simple comparison of the dietary exposure data in foods with the Australian Tolerable Monthly Intake (TMI) did not raise any public health concerns as the results are all below the TMI. The overall risk to Australian consumers following the consumption of foods containing dioxins was considered to be very low for individuals in all age groups.

While noting that there are no immediate areas of public health concern, the Department of Health and Ageing has identified the need to reduce where possible, the emission of dioxin-like compounds to the environment. While concluding that there are no immediate areas of public health concern, the Department of Health and Ageing also noted the need to reduce, where possible, the emission of dioxin-like compounds to the environment. Specifically, the Department recommended, *inter-alia* that reducing the levels of dioxins in feed given to livestock, poultry and aquaculture fish would help to reduce the levels of dioxins in the food supply.

6. Off-Label Use [7]

As noted above, all pesticide and veterinary medicine products must be registered prior to sale and use. Registration incorporates the approval of a product label, and the use-pattern associated with each approved use outlined on the label. Appropriate standards such as MRLs are established for each food commodity on which the product is approved. Use of products in a manner contrary to label directions is termed 'off-label' use and may be an offence under State law.

Off-label use can include the use of a registered product on approved food commodities but contrary to the label directions eg at higher application rates or it can encompass the use of a chemical product on a food commodity not included on the label. Off-label uses have not been considered during the risk-assessment and registration process and can result in adverse effects on people and the environment. Where off-label use results in residues, food may be considered adulterated and in breach of State Food laws. Industry reputations both domestically and overseas can be seriously affected, including the possible loss of export markets.

In the use of veterinary drugs, off-label use encompasses the prescribing of chemicals by veterinarians for purposes and in a manner contrary to, or in a way that was not considered in the risk assessment during the registration process. However, off-label use by veterinarians recognises their professional training and expertise and is permitted under State control-of-use legislation. Unfortunately, State laws in this area are not harmonised and considerable effort is currently underway to achieve harmonisation.

Regulators have generally accepted that veterinary training provides a sound basis on which to allow veterinarians to use products off-label. That acceptance has been qualified so that certain restrictions are now being applied to veterinarians reasonably consistently across all jurisdictions.

Supply controls

The Commonwealth Agricultural and Veterinary Chemicals Code Act 1994 (the Agvet Code) allows supply of unregistered veterinary chemical products by veterinarians only when it is approved under State or Territory legislation.

For companion animals – including horses – most jurisdictions permit the supply of human pharmaceuticals and products which are compounded either by a veterinarian or by a pharmacist on the prescription of a veterinarian.

In Victoria *supply* by veterinarians of unregistered products to clients for treating major food species is limited to an amount for the treatment of only one animal. In other jurisdictions, use, prescription or supply of such products for treating major food species is limited to use/supply for only one animal.

Use of unregistered products

Human drugs and products compounded personally by veterinarians may be supplied for, and used in, companion animals. Other unregistered products for pet animals usually require a permit (but not in Victoria).

Products for use in research trials require permits.

[7] The current situation in respect to supply controls, use of unregistered products and off-label use was provided by Dr Lee Cook (NSW Department of Agriculture, Fisheries and Forestry) and Dr Tom Grimes.

In all jurisdictions, use of any unregistered chemical on major food species (in all jurisdictions cattle, sheep, pigs and chickens are major food species, plus various other species are included in the different jurisdictions) is prohibited.

The only exception is that a single animal may be treated with an unregistered product (with slight variation in South Australia and Victoria). The single animal exemption provision is to allow the treatment of valuable, individual animals (e.g. a breeding sow or stud bull) where the attending veterinarian considers that the normal treatment options will not work.

In Victoria a veterinarian cannot *supply/sell* an unregistered veterinary chemical product to a client to treat more than one stock animal, though they can theoretically *use* it on more than one animal.

Note that in relation to any unregistered product it is illegal to directly import it without a permit from the Australian Pesticides and Veterinary Medicines Authority (APVMA).

Off-label use

Any unregistered product can be used in all jurisdictions, by veterinarians, to treat companion animals (in some jurisdictions owners can do the same).

Veterinarians can use products off-label in all species and give written instructions to clients to do so. In all jurisdictions, only products already registered in one major food species (cattle, sheep, pigs, poultry etc, with some variation between jurisdictions) can be used off-label *by veterinarians, or under written veterinary direction,* to treat animals of another major food species. In Victoria any registered product can be so used. Some flexibility (this is variable between jurisdictions, with some less flexible) is being provided in regard to other food species and off-label use in them, so less veterinary intervention may be required in some jurisdictions.

Farmers in Victoria can treat any minor species (not cattle, sheep, pigs or chickens) with any registered product not prohibiting such use on the label, provided they do not increase the dose rates, therefore veterinary intervention is theoretically not required.

Restraint and "DO NOT" statements

In all jurisdictions veterinarians cannot (will not be able to) use a product contrary to any (restrictive) statement under a "Restraint" heading e.g. "Restraint: Not to be used in food producing species of animals". The APVMA has agreed that only statements of genuine restraint will be included under this heading in future. (In South Australia only those Restraint statements prescribed by the Department of Primary Industries and Resources SA will apply.)

In all jurisdictions, except Victoria, veterinarians may use a product contrary to any other "DO NOT" type statements which do *not* appear under a "restraint" heading, e.g. "DO NOT treat pregnant animals". In Victoria all such statements, whether under a "restraint" heading or not, have force for all users **including veterinarians.**

Given that many statements which should be included under the new Restraint heading are not yet included there, particularly those prohibiting use in food producing species of animals, it is essential that veterinarians in all jurisdictions, not just Victoria, comply with all label prohibitions against use in food producing species. (It is likely that each jurisdiction will impose specific controls to make this a legal requirement until the APVMA can get all products correctly labelled.)

(Note that, in NSW *only*, products applied externally to animals to kill external parasites (dips, pour-ons etc) are not covered by this legislation. They are defined as pesticides under the NSW Pesticides Act 1999 and must be used strictly according to label directions – even by veterinarians.)

Clearly the current supply and off-label use provisions under State laws are complex and in need of harmonisation. For the egg industry some key points to note about the current control-of-use situation are:

- Off label use by non-veterinarians is prohibited in Qld, NSW, Victoria and Tasmania and is proposed in SA, WA and NT. It is not proposed in the ACT.
- Off-label use is permitted for veterinarians only in all States (except WA and the NT where it is proposed). No provisions exist in the ACT.
- It is an offence for anyone to use a product contrary to a label restraint statement except in SA, WA and the NT where the provision is proposed.
- Labels or advice notes are required for products dispensed by veterinarians in all states except NSW, SA, WA, and the NT where the provision is proposed. No provision exists in the ACT.
- It is an offence to cause violative residues in animal products in all states except NSW, WA and the NT where the offence is proposed. It not an offence in the ACT.
- It is an offence to give advice resulting in violative residues in food producing animals in all, states except SA, WA and the NT where the provision is proposed. This is not the case in the ACT.
- Veterinarian supply and treatment records are required for all off-label, unregistered or S4 use in all states except NSW, SA, WA and the NT where the provision is proposed. It is not proposed in the ACT.

Legislative changes to bring about harmonisation are expected by the end of 2004.

While under State control-of-use laws it will be an offence to cause violative residues in animal products, the use of chemicals without MRLs is permitted. Whether this remains desirable in a climate of increasing consumer concern about food safety is a policy matter for industry consideration. It could be that a program of securing permits and/or MRLs may, in the longer term, place the egg industry in a stronger position in respect to food safety while at the same time securing continued and accepted use of essential chemicals.

Summary
In all jurisdictions, use of any unregistered chemical on major food species (in all jurisdictions cattle, sheep, pigs and chickens are major food species, plus various other species are included in the different jurisdictions) is prohibited.

Veterinarians can use products off-label in all species and give written instructions to clients to do so. In all jurisdictions, only products already registered in one major food species (cattle, sheep, pigs, poultry etc, with some variation between jurisdictions) can be used off-label *by veterinarians, or under written veterinary direction,* to treat animals of another major food species. In Victoria any registered product can be so used. Some flexibility (this is variable between jurisdictions, with some less flexible) is being provided in regard to other food species and off-label use in them, so less veterinary intervention may be required in some jurisdictions.

Farmers in Victoria can treat any minor species (not cattle, sheep, pigs or chickens) with any registered product not prohibiting such use on the label, provided they do not increase the dose rates, therefore veterinary intervention is theoretically not required.

In all jurisdictions veterinarians cannot (will not be able to) use a product contrary to any (restrictive) statement under a "Restraint" heading

Except in the ACT it is (or will be) an offence in all States to cause violative residues in animal products. Furthermore, it is (or will be) an offence to give advice resulting in violative residues in food producing animals.

Legislative changes to bring about harmonisation are expected by the end of 2004.

7. Conclusions and Recommendations

From this study we conclude that;

- Based on the available information, there is no evidence that residues of pesticides, veterinary medicines or other contaminants in whole eggs present a food safety or public health risk.

- The absence of domestic MRLs and public health standards (ADIs) for some chemicals of importance to the egg industry is of concern and could result in eggs being in breach of Food Standards. The absence of such standards may also lead to a perception of a food safety concern should residues at any level be detected.

- With the exception of dimetridazole and antibiotic use, there is currently no known public health concern associated with any of the chemical products identified as being of importance to the egg industry. The issue of antibiotic use and the possibility of resistance development in humans have been investigated through JETACAR with the cooperation of user industries. As a result, regulatory processes have been modified and specific product reviews are currently underway. The outcome may have implications for the egg industry should products be lost from the market. Carbaryl use is being withdrawn in response to occupational health and safety concerns.

- While there is no immediate concern in respect to the level of contaminants in eggs, the level of dioxins should be closely monitored.

- Residue monitoring information provided by way of the National Residue Survey and the Australian Total Diet Study is limited, especially in regard to inhibitory substances and individual and more modern pesticides and veterinary drugs used in the egg industry.

- Chemical issues facing the egg industry (but outside the scope of this review) include the loss of valuable chemicals as a result of reviews of old chemicals, concerns in regard to occupational health and safety, off-label use and the development, registration and availability of new chemicals for minor use industries such as the Australian egg industry.

It is **recommended** that:

- The Australian egg industry moves to ensure that, as appropriate, all chemicals used in the industry have MRLs established.

- An appropriate egg program be developed within the National Residue Survey that reflects contemporary chemical use practices within the egg industry.

- The egg industry explore in consultation with the APVMA, a minor-use program aimed at securing minor use permits and MRLs for chemicals of importance to the egg industry and therefore less reliance on off-label use by veterinarians.

- The Australian egg industry works closely with Food Standards Australia New Zealand in their consideration and setting of appropriate food standards for dioxins.

- The egg industry continues to recognise chemical residues as an issue of public and political interest and a potential area of food safety concern.

APPENDIX A

PESTICIDES AND VETERINARY MEDICINES REGISTERED FOR USE ON POULTRY (INCLUDING LAYING POULTRY) BY THE AUSTRALIAN PESTICIDES AND VETERINARY MEDICINES AUTHORITY (APVMA)

APVMA Product Code	Product Name [Active Ingredient(s)]	Approved Use
30193	ASEPTOL GERMICIDE, DISINFECTANT AND DETERGENT [chlorhexidine, cetrimide]	POULTRY
30193	ASEPTOL GERMICIDE, DISINFECTANT AND DETERGENT [chlorhexidine, cetrimide]	POULTRY SHED
31114	ANTEC HDD HEAVY DUTY DISINFECTANT DETERGENT	POULTRY SHED
31127	ANTEC INTERNATIONAL ANTEC FARM FLUID DISINFECTANT [sodium edetate, sodium metasilicate pentahydrate, didecyl benzene trimethyl ammonium chloride]	POULTRY SHED
32708	RUDCHEM PY SPRAY AEROSOL INSECTICIDE [Piperonyl butoxide, pyrethrin]	POULTRY SHED
32712	RUDCHEM PY 40-FORMULA 40 INSECTICIDE [Piperonyl butoxide, pyrethrin]	POULTRY SHED
32713	PYMATIC METERED INSECTICIDE [Piperonylt butoxide, pyrethrin]	POULTRY SHED
33018	NUFARM MALDISON 500 INSECTICIDE [Maldison]	POULTRY SHED
33021	PHARMACHEMICAL MALDISON 50 INSECTICIDE [Maldison]	POULTRY
33021	PHARMACHEMICAL MALDISON 50 INSECTICIDE [Maldison]	POULTRY SHED
33102	DIPTEREX 500 SL INSECTICIDE [Trichlorfon]]	POULTRY SHED
33530	E-Z-LICER POULTRY INSECTICIDE [Maldison]	POULTRY PEN, ROOST OR NEST LITTER
35534	DOT 125 PREMIX COCCIDIOSTAT FOR POULTRY [Dinitolmide]	POULTRY [Not for laying poultry]
35534	DOT 125 PREMIX COCCIDIOSTAT FOR POULTRY [Dinitolmide]	POULTRY PULLETS (GROWING CHOOK) [Not for laying poultry]
35541	OXYTETRACYCLINE SOLUBLE MEDICATION FOR POULTRY [Oxytetracycline]	POULTRY
35662	TRICON POWDER SOLUBLE ANTIBIOTIC POWDER FOR ORAL USE [Chlortetracycline]	POULTRY
35759	INFECTIOUS BRONCHITIS VACCINE NO 1 [Vaccine]	POULTRY
35783	TOLTRO COCCIDIOSTAT FOR POULTRY [Diaveridine, sulfaquinoxaline, Vitimin K]	POULTRY
35784	AGROTECH AVISOL LIQUID PIG AND POULTRY WORMER [Levamisole]	POULTRY

35907	VAXSAFE MG VACCINE MYCOPLASMA GALLISEPTICUM STRAIN TS-11 VACCINE, LIVING [Vaccine]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
35988	TETRAVET 100 SOLUBLE ANTIBIOTIC POWDER [Oxytetracycline]	POULTRY
36123	TRIBRISSEN WATER MEDICATION [Trimethoprim, sulfadiazine]	POULTRY
36171	COOPERS NILVERM PIG AND POULTRY WORMER [Levamisole]	POULTRY
36430	CCD PIPERAZINE [Piperazine]	POULTRY
36437	CCD TYLAN SOLUBLE [Tylosin]	PULLET - REPLACEMENT
36443	CCD AMOXYCILLIN TRIHYDRATE FOR POULTRY [Amoxycillin]	POULTRY
36528	A.F.S TRIMSUL ANTIMICROBIAL SOLUBLE POWDER [Tirmethoprim, sulfadiazine[	POULTRY
36529	A.F.S TRIMSUL ANTIMICROBIAL SOLUTION [Trimethoprim, sulfadiazine]	POULTRY
36530	A.F.S OXYTET SOLUBLE [Oxytetracycline]	POULTRY
36531	A.F.S TYLAN SOLUBLE TYLOSIN TARTRATE POWDER [Tylosin]	POULTRY
36611	TUBERCULIN PPD (AVIAN) [Vaccine]	POULTRY
36645	AUROFAC 200 ANTIBIOTIC FEED SUPPLEMENT GRANULATED [Chlortetracycline]	POULTRY
36657	AUREOMYCIN 950 SOLUBLE CONCENTRATE [Chlortetracycline]	POULTRY
36657	AUREOMYCIN 950 SOLUBLE CONCENTRATE [Chlortetracycline]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
36658	AUREOMYCIN 30 ANTIBIOTIC POWDER [Chlortetracycline]	POULTRY
36755	SELENIUM DRENCH CONCENTRATE [Selenium]	POULTRY
36787	ELANCO AF1304 ELANCOBAN G MONENSIN SODIUM PREMIX [Monensin]	PULLET-LAYING REPLACEMENT
37089	STENOROL ANTICOCCIDIAL FOR BROILERS [Halofuginone]	POULTRY
37122	KEYMIX KEYLECTROLYTES KEY 56 ELECTROLYTE REPLACERS [Electrolytes]	POULTRY
37123	KEYMIX SOLQUIN KEY 125 FOR THE TREATMENT AND PREVENTION OF CAECAL AND INTESTINAL COCCIDIOSIS IN POULTRY [Diaverdine, sulfaquinoxaline]	POULTRY
37126	KEYMIX SULPHATRIM ORAL SULPHADIAZINE AND TRIMETHOPRIM MEDICATION [Sulfadimidine, trimethoprim]	POULTRY
37127	KEYMIX KEYSTAT KEY 25 COCCIDIOSTAT SOLUTION FOR THE TREATMENT OF COCCIDIOSIS IN POULTRY [Amprolium, ethopabate]	POULTRY
37185	INCA SULPHA-QUIN CONCENTRATE FOR THE PREVENTION AND TREATMENT OF COCCIDIOSIS IN POULTRY [Sulfaquinoxaline]	POULTRY
37188	INCA PIPERAZINE SOLUTION [Piperazine]	POULTRY
37202	INCA PESTENE INSECT POWDER [Rotenone, sulphur]	POULTRY
37407	NYCEX DISINFECTANT [Chloramine]	POULTRY
37518	AMPROLMIX-PLUS COCCIDIOSTAT [Amprolium, ethopabate]	POULTRY

37519	AMPROLMIX PLUS COCCIDIOSTAT SOLUTION [Amprolium, ethopabate]	POULTRY
37624	ALL-LAC [Lactobacillus etc] -- Dietary Supplement	POULTRY
37625	LACTO-SACC [Dried yeast product]	POULTRY
37626	ACID-PAK 4-WAY W.S. [Enzymes]	POULTRY
37721	TRIMIDINE POWDER [Trimethoprim, sulfadimidine]	POULTRY
37803	NEO-TERRAMYCIN 50/50 SOLUBLE POWDER CONCENTRATE [Neomycin, Terramycin]	POULTRY
38037	EMTRYL PREMIX FOR FEED MEDICATION [Dimetridazole]	POULTRY
38038	EMTRYL SOLUBLE DIMETRIDAZOLE SOLUBLE POWDER 400G/KG [Dimetridazole]	POULTRY
38065	SOLULYTE CONCENTRATE ELECTROLYTE REPLACER PLUS VITAMIN A [Electrolytes, Vitamin A]	POULTRY
38116	ALBAC 150 ANTIBIOTIC FEED PREMIX [Zinc bacitracin]	POULTRY
38118	AVATEC LASALOCID SODIUM COCCIDIOCIDAL PREMIX [Lasalocid]	PULLET - REPLACEMENT
38173	RUDDUCKS BIRD WORMER [Piperazine hydrochloride]	POULTRY
38425	SYKES BIG L WORMER FOR POULTRY & PIGS [Levamisole]	POULTRY
38731	CETRIGEN ANTIBACTERIAL WOUND AEROSOL [Diethyltoluamide, cetrimide]	POULTRY
38975	WEBSTERS BURSAVAC K INFECTIOUS BURSAL DISEASE VACCINE (OIL ADJUVANTED INACTIVATED V877 STRAIN VIRUS) [Vaccine]	POULTRY
38988	WEBSTERS FOWL POX VACCINE (M STRAIN, LIVE VIRUS, SPF) [Vaccine]	POULTRY
38994	WEBSTERS AVIAN ENCEPHALOMYELITIS VACCINE (I STRAIN, LIVE VIRUS, SPF) [Vaccine]	POULTRY PULLETS (GROWING CHOOK)
38999	CHOLERA VACCINE [Vaccine]	POULTRY
39004	MAREK'S DISEASE VACCINE (HVT) [Vaccine]	POULTRY
39006	WEBSTERS INFECTIOUS BRONCHITIS VACCINE (VIC S STRAIN, LIVE VIRUS, SPF) [Vaccine]	POULTRY
39007	WEBSTERS INFECTIOUS BRONCHITIS VACCINE-ARMIDALE A3 STRAIN-LIVE VIRUS [Vaccine]	POULTRY
39007	WEBSTERS INFECTIOUS BRONCHITIS VACCINE-ARMIDALE A3 STRAIN-LIVE VIRUS [Vaccine]	POULTRY PULLETS (GROWING CHOOK)
39008	WEBSTERS INGHAM STRAIN INFECTIOUS BRONCHITIS VACCINE (LIVE VIRUS, S.P.F.) [Vaccine]	POULTRY
39011	WEBSTERS CORYZA VACCINE HAEMOPHILUS PARAGALLINARUM TYPES A AND C [Vaccine]	POULTRY
39558	A.F.S AMOXCILIN SOLUBLE AMOXYCILLIN TRIHYDRATE POWDER [Amoxycillin]	POULTRY

39774	PROTOSAN SANITISER [Glutaraldehyde]	POULTRY PEN, ROOST OR NEST LITTER
39890	WEBSTERS INFECTIOUS LARYNGOTRACHEITIS VACCINE (A20 STRAIN, LIVE VIRUS, SPF) [Vaccine]	POULTRY
39915	EGG DROP SYNDROME VACCINE [Vaccine]	POULTRY
39971	PIPERAZINE WORM POWDER [Piperazine]	POULTRY
40178	TERRAMYCIN 400 FEED SUPPLEMENT [Terramycin]	POULTRY
40217	ELANCO AF1300 TYLAN TYLOSIN TARTRATE SOLUBLE [Tylosin]	PULLET - REPLACEMENT
40323	OTC 200 FOR FEED MEDICATION [Oxytetracycline]	POULTRY
40472	KEYMIX KEYSTAT POWDER FEED ADDITIVE COCCIDIOSTAT FOR POULTRY [Amprolium]	PULLET - REPLACEMENT
40512	OXYMAV 100 SOLUBLE BROADSPECTRUM ANTIBIOTIC POWDER [Oxytetracycline]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
40531	CCD SULFAQUINOXALINE [Sulfaquinoxaline]	POULTRY
40535	CCD D.O.T. (DINITOLMIDE) FEED ADDITIVE COCCIDIOSTAT [Dinitolamide]	PULLET - REPLACEMENT
40538	YEA-SACC 1026 [Saccharomycees cerevisiae] Biological organism	POULTRY
40542	FOWL POX VACCINE [Vaccine]	POULTRY
40672	CIBA GEIGY DYNAMUTILIN 125 SOLUTION FOR PIGS AND CHICKENS [Tiamulin]	POULTRY
40704	DOT PREMIX ANTICOCCIDIAL FOR FEED MEDICATION [Dinitro-o-toluamide]	PULLET - REPLACEMENT
40728	SALVAX SALMONELLA VACCINE [Vaccine]	POULTRY
40807	AMPROLIUM 200 SOLUBLE POWDER [Amprolium[	PULLET - REPLACEMENT
41177	G.A.H. FORMULA OXYTETRACYCLINE PLUS MULTIVITAMINS [Oxytetracycline]	POULTRY
41178	GAH FORMULA ELECTROLYTE PLUS GLUCOSE	POULTRY
41228	PHARMA-CHEMICAL PIPERAZINE SOLUTION FOR THE REMOVAL OF ROUNDWORMS FROM PIGS, POULTRY, PIGEONS & CAGE BIRDS [Piperazine]	POULTRY
41244	DAVID SKATTA-7 TICK FLEA LOUSE POWDER [Carbaryl]	POULTRY
41249	PHARMA-CHEMICAL PHARMONIA [Cresylic Acid]	POULTRY SHED
41283	ELECTROLYTE 72 ELECTROLYTE REPLACEMENT THERAPHY FOR PIGS AND POULTRY [Potassium Citrate, Sodium]	POULTRY
41414	ANIGANE [Fe, Mn, Na, K]	POULTRY
41417	STOCADE WATER SOLUBLE [Vitamin A,D,E]	POULTRY
41450	AGRIQUAT DISINFECTANT-SANITIZER-DEODORANT [Benzalkonium chloride]	POULTRY DRINKING WATER
41451	AGRISAN DISINFECTANT AND LITTER SPRAY [Cresylic Acid]	POULTRY SHED
41452	AGRIPHOR DISINFECTANT SANITIZER AND DEODORANT [Iodine, Phosphoric Acid]	POULTRY SHED
41468	BRONSON AND JACOBS PTY LTD NEOMYCIN SULPHATE AG GRADE [Neomycin]	POULTRY

41469	BRONSON AND JACOBS AMOXYCILLIN TRIHYDRATE POWDER BP [Amoxycillin]	POULTRY
41559	HIBITASE CONCENTRATE – 100 [Yucca extract]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
41609	OLIVITASOL - A WATER-SOLUBLE VITAMIN, MINERAL AND AMINO ACID SUPPLEMENT	POULTRY
41943	TETRACIN 10 SOLUBLE POWDER [Oxytetracycline]	POULTRY
42019	WEBSTERS NEWCASTLE DISEASE VACCINE "V4 STRAIN" SPF (LIVING) [Vaccine]	POULTRY
42250	WEBSTERS MARAVAC MAREK'S DISEASE VACCINE (LIVING) (STRAIN MD 19) [Vaccine]	POULTRY
42267	DAVID GRAYS POULTRY DUST [Maldison]	POULTRY
42335	HALAMID FUNGICIDE DISINFECTANT - COMMERCIAL GRADE [Chloramine]	POULTRY SHED
42336	TRIMETSULPHA (WATER SOLUBLE) [Trimethoprim, sulfadiazine]	POULTRY
42338	TETRACIN 200 [Oxytetracycline]	POULTRY
42339	TETRACIN 100 SOLUBLE POWDER [Oxytetracycline]	POULTRY
42553	SANI-CHICK GENERAL PURPOSE GERMICIDE [Iodine]	POULTRY
42553	SANI-CHICK GENERAL PURPOSE GERMICIDE [Iodine]	POULTRY SHED
42697	AGRIGARD SANITISER	POULTRY SHED
45117	LEVAMISOLE CONCENTRATE ANTHELMINTIC FOR POULTRY [Levamisole]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
45117	LEVAMISOLE CONCENTRATE ANTHELMINTIC FOR POULTRY [Levamisole]	PULLET - REPLACEMENT
45118	COXITROL SOLUBLE POWDER	POULTRY
45124	ALLFARM PIPERAZINE WORMER FOR POULTRY [Piperazine]	POULTRY
45246	Q.E.A. AMOXYCILLIN TRIHYDRATE FOR POULTRY [Amoxycillin]	POULTRY
45247	G.A.H. AMOXYCILLIN TRIHYDRATE FOR POULTRY [Amoxycillin]	POULTRY
45256	TIAMUTIN SOLUTION [Tiamulin]	POULTRY
45263	TIAMUTIN PREMIX [Tiamulin]	POULTRY
45271	TIAMUTIN WATER SOLUBLE POWDER [Tiamulin]	POULTRY
45499	NUFARM SELENIUM CONCENTRATE DRENCH FOR CATTLE, SHEEP AND POULTRY [Selenium]	POULTRY
45626	BAYCOX COCCIDIOCIDE SOLUTION [Toltrazuril]	POULTRY
46011	WEBSTERS INFECTIOUS BURSAL DISEASE VACCINE (STRAIN V877, LIVE VIRUS) [Vaccine]	POULTRY
46067	A.V.S. AMPROSOL SOLUBLE COCCIDIOSTAT POWDER [Amprolium, Ethopabate]	POULTRY
46142	CCD SULFADIMIDINE SODIUM SOLUBLE [Sulfadimidine]	POULTRY
46254	ACTISAN SANITISER [Glutaraldehyde, QAC]	POULTRY SHED

46494	AGROTECH AMOXYCILLIN SOLUBLE POWDER [Amoxycillin]	POULTRY
46539	GROWERS GLUTASAN LIQUID SANITISER [Glutaraldehyde, QAC]	POULTRY SHED
46541	GROWERS SUPER SAN NEW GENERATION SANITISER [QAC]	POULTRY SHED
46830	TERRAMYCIN 880 SOLUBLE POWDER CONCENTRATE [Oxytetracycline]	POULTRY
46851	KEYDUST DUSTING POWDER [Carbaryl, maldison]	POULTRY
46851	KEYDUST DUSTING POWDER [Carbaryl, maldison]	POULTRY PEN, ROOST OR NEST LITTER
46851	KEYDUST DUSTING POWDER [Carbaryl, maldison]	POULTRY SHED
46864	KONK I METERED INSECTICIDE [Piperonyl butoxide, pyrethrins]	POULTRY SHED
47097	POLYPHEN POLYPHENOLIC MICROBIOCIDE [Phenol]	POULTRY PEN, ROOST OR NEST LITTER
47167	AVIZYME TYPE 1310 LIQUID FOR WHEAT BASED POULTRY FEEDS [Enzyme – Xylenase]	POULTRY
47230	TUGON PLUS BAYER FLY BAIT [Methomyl, tricosene]	POULTRY SHED
47238	SAHELY FORMALIN FORMALDEHYDE SOLUTION [Formaldehyde]	POULTRY FARM
47240	POULTONE ADS-110 ALKALINE LIQUID DETERGENT-SANITIZER [Benzalkonium chloride]	POULTRY SHED
47348	BRONSON AND JACOBS OXYTETRACYCLINE HYDROCHLORIDE ORAL POWDER [Oxytetracycline]	POULTRY
47359	ELANCO AF1404 RUMENSIN 100 MONENSIN SODIUM [Monensin]	POULTRY
47399	OXYKIL DISINFECTANT [Hydrogen peroxide, peroxyacetic acid]	POULTRY SHED
47424	AVIZYME TYPE 1210 LIQUID FOR BARLEY/WHEAT-BASED POULTRY FEEDS [Enzyme]	POULTRY
47508	KEYMIX KEYCARBAZIN FEED ADDITIVE COCCIDIOSTAT FOR BROILER BIRDS AND REPLACEMENT PULLETS [Nicarbazin]	PULLET - REPLACEMENT
47613	GROWERS CRESI-SAN LIQUID SANITISER [Cresol]	POULTRY PEN, ROOST OR NEST LITTER
47613	GROWERS CRESI-SAN LIQUID SANITISER [Cresol]	POULTRY SHED
47736	PROTEXIN SOLUBLE CONCENTRATED MULTI-STRAIN PROBIOTIC FOR ANIMALS AND BIRDS [Biological]	POULTRY
47737	PROTEXIN POWDER MULTI-STRAIN PROBIOTIC FOR ANIMALS AND BIRDS [Biological]	POULTRY (SEE LABEL)
47894	BIO-FEED ALPHA CT [Enzymes]	POULTRY
47895	BIO-FEED ALPHA L [Enzymes]	POULTRY
47896	BIOFEED PLUS CT XYLANASE AND BETA-GLUCANASE ENZYME COMPLEX [Enzymes]	POULTRY
47897	BIOFEED PLUS L XYLANASE AND BETA-GLUCANASE ENZYME COMPLEX	POULTRY

	[Enzymes]	
47922	ROXAZYME G MULTIENZYME COMPLEX FOR POULTRY [Enzymes]	POULTRY
47985	VAXSAFE MS VACCINE MYCOPLASMA SYNOVIAE STRAIN MS-H VACCINE, LIVING [Vaccine]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
47985	VAXSAFE MS VACCINE MYCOPLASMA SYNOVIAE STRAIN MS-H VACCINE, LIVING [Vaccine]	POULTRY PULLETS (GROWING CHOOK)
47987	PYSECT METERED INSECTICIDE [Piperonyl butoxide, pyrethrins]	POULTRY SHED
48182	LINCO-SPECTIN ANTIBIOTIC SOLUBLE POWDER FOR POULTRY AND SWINE [Lincospectin, spectinomycin]	POULTRY
48265	BMD-100 ANTIBIOTIC FEED PREMIX [Bacitracin]	POULTRY
48333	DIGEST 'M' FEED MATE GRAIN SORGHUM SPECIFIC ENZYMES CARBOZYME [Enzyme]	POULTRY
48512	AGROTECH TRIMETHOSOL - WATER MEDICATION ORAL SULFADIAZINE AND TRIMETHOPRIM [Trimethoprim, sulfadiazine]	POULTRY
48530	ROXAZYME G2 LIQUID MULTIENZYME COMPLEX FOR POULTRY [Enzyme]	POULTRY
48581	GLUTA BAC GLUTARALDEHYDE SANITISER [Glutaraldehyde]	POULTRY PEN, ROOST OR NEST LITTER
48581	GLUTA BAC GLUTARALDEHYDE SANITISER [Glutaraldehyde]	POULTRY SHED
48607	TUGON 100 WP FLY & LITTER BEETLE INSECTICIDE [Cyfluthrin]	POULTRY SHED
48789	FARMOZ PERMEX RESIDUAL INSECTICIDE [Permethrin]	POULTRY SHED
48832	BIO-FEED WHEAT CT [Enzymes]	POULTRY
48833	BIO-FEED WHEAT L [Enzymes]	POULTRY
48838	COXISTAC BROAD SPECTRUM COCCIDIOCIDAL FEED ADDITIVE PREMIX [Salinomycin]	PULLET-LAYING REPLACEMENT
49052	COXISTAC 120 ANTICOCCIDIAL PREMIX FEED ADDITIVE PREMIX [Salinomycin]	POULTRY
49057	KEMZYME W LIQUID [Enzyme]	POULTRY
49058	KEMZYME W DRY [Enzyme]	POULTRY
49059	KEMZYME B DRY [Enzyme]	POULTRY
49060	KEMZYME S LIQUID [Enzyme]	POULTRY
49061	KEMZYME S DRY [Enzyme]	POULTRY
49146	GRINDAZYM GPL 5000 FEED ENZYME [Enzyme]	POULTRY
49182	DAIRY POWER EZE-FOME HIGH FOAM ALKALINE DETERGENT [Chlorine as sodium hypochlorite & Potassium hydroxide]	POULTRY SHED
49236	RCI OZ IB VACCINE INFECTIOUS BRONCHITIS VACCINE [Vaccine]	POULTRY (SEE LABEL)

49290	FOG IT INSECT KILLER [Piperonyl butoxide, pyrethrins]	POULTRY SHED
49421	NOBILIS GUMBORO INACTIVATED VACCINE [Vaccine]	POULTRY
49449	ALFACRON 500 RESIDUAL INSECT SPRAY [Azamethiphos]	POULTRY
49449	ALFACRON 500 RESIDUAL INSECT SPRAY [Azamethiphos]	POULTRY SHED
49485	AVIZYME TYPE 1510 LIQUID FOR POULTRY FEED [Enzyme]	POULTRY
49535	ALFACRON 10 PLUS RESIDUAL INSECT SPRAY [Azamethiphos, Tricosene]	POULTRY SHED
49538	FYFANON 500 EC INSECTICIDE [Maldison]	POULTRY SHED
49640	TERRAMYCIN 550 FEED SUPPLEMENT POWDER [Terramycin]	POULTRY
49674	ENERGEX CT [Enzyme]	POULTRY
49675	ENERGEX L [Enzyme]	POULTRY
49695	TERRAMYCIN 200 FEED SUPPLEMENT [Terramycin]	POULTRY
49914	PROTEXIN PROFESSIONAL CONCENTRATED MULTI-STRAIN PROBIOTIC FOR ANIMALS AND BIRDS [Biological]	POULTRY
50008	NOBILIS EDS INACTIVATED VACCINE FOR LAYING HENS [Vaccine]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
50141	BRONSON AND JACOBS DIMETRIDAZOLE (D.M.Z.) ORAL [Dimetridazole]	POULTRY
50143	BRONSON AND JACOBS DINITRO-ORTHOTOLUAMIDE (D.O.T.) ORAL POWDER [Dinitro-o-toluamine]	PULLET - REPLACEMENT
50235	POSISTAC 60 GROWTH PROMOTANT AND ANTICOCCIDIAL FEED PREMIX [Salinomycin]	PULLET - REPLACEMENT
50485	MAREK'S DISEASE VACCINE MAREK'S DISEASE VIRUS, STRAIN CVI 988, LIVING CELL ASSOCIATED [Vaccine]	POULTRY
50502	NEPOREX 2 GR INSECT GROWTH REGULATOR [Cyromazine]	POULTRY FARM
50557	AVIZYME TYPE 1302 PREMIX FOR WHEAT BASED POULTRY FEEDS [Enzyme]	POULTRY
50573	WEBSTERS INFECTIOUS LARYNGOTRACHEITIS VACCINE (SA2 STRAIN, LIVE VIRUS, SPF) [Vaccine]	POULTRY
50696	ELANCO AF0168 RUMENSIN GRANULAR MONENSIN SODIUM [Monensin]	POULTRY
50735	PACIFLOR C 10 PROBIOTIC FEED ADDITIVE [Biological organism]	POULTRY
50742	CCD ERYTHROMYCIN (WATER SOLUBLE POWDER) [Erythromycin]	POULTRY
50743	CCD DIMETRIDAZOLE (WATER SOLUBLE POWDER) [Dimetridazole]	POULTRY
50860	VIRUKILL DISINFECTANT [Quaternary Ammonium Compound]	POULTRY SHED
50937	B & J 3-NITRO 1000 FEED ADDITIVE POWDER [Roxarsone (mineral arsenic)]	POULTRY
50937	B & J 3-NITRO 1000 FEED ADDITIVE POWDER [Roxarsone (mineral arsenic)]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
50965	NATUPHOS 5000 LIQUID SPECIFIC PHYTASE FEED ENZYME FOR PIGS AND	POULTRY

	POULTRY [Enzyme]	
50969	ALLZYME VEGPRO LIQUID AN ENZYME SUPPLEMENT FOR VEGETABLE PROTEIN INGREDIENTS IN POULTRY AND PIG FEEDS. [Enzyme]	POULTRY FEED
50996	POSISTAC 450 GROWTH PROMOTANT AND ANTICOCCIDIAL FEED PREMIX [Salinomycin]	PULLET - REPLACEMENT
51132	KEMZYME HF DRY [Enzyme]	POULTRY
51135	GLUTAPLUS LIQUID SANITISER [Glutaraldehyde, QAC]	POULTRY SHED
51173	BIO-COX 120G ANTICOCCIDIAL PREMIX [Salinomycin]	PULLET - REPLACEMENT
51261	NATUPHOS 5000 GRANULATE SPECIFIC PHYTASE FEED ENZYME FOR PIGS AND POULTRY [Enzyme]	POULTRY
51369	RHONE-POULENC ANIMAL NUTRITION DYNAMUTILIN 125 SOLUTION FOR PIGS AND CHICKENS [Tiamulin]	POULTRY
51378	NATUGRAIN BLEND GRANULATE COMPLEX NSP ENZYME FOR POULTRY AND PIGS [Enzyme]	POULTRY
51379	NATUGRAIN BLEND LIQUID COMPLEX NSP ENZYME FOR POULTRY AND PIGS [Enzyme]	POULTRY
51700	CHICK GLUTE F LIQUID SANITISING COMPLEX [Glutaraldehyde, QAC]	POULTRY SHED
51718	SULPRIM ORAL POWDER [Trimethoprim, sulfadimidine]	POULTRY
51753	ORICA AMOXYCILLIN TRIHYDRATE SOLUBLE ORAL POWDER [Amoxycillin]	POULTRY
51754	A.L. 3-NITRO 1000 FEED ADDITIVE POWDER [Roxarsone (mineral arsenic)]	POULTRY
51877	AEV GLYCERINATED LIVE VACCINE [Vaccine]	POULTRY
52016	CCD 3-NITRO (GROWTH PROMOTANT FEED ADDITIVE POWDER) [Roxarsone (mineral arsenic)]	POULTRY
52208	MONECO 200 FEED ADDITIVE POWDER FOR CATTLE, GOATS AND POULTRY [Monensin]	POULTRY (SEE LABEL)
52210	CTC-ECO ORAL POWDER [Chlortetracycline]	POULTRY
52211	OXY-ECO ORAL POWDER [Chlortetracycline]	POULTRY
52231	SALINDOX 60 BMP MICROGRANULATE FEED ADDITIVE [Salinomycin]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
52293	ZINC BACITRACIN 150 G/KG GRANULATE -FEED PREMIX [Zinc Bacitracin]	POULTRY
52307	LARVADEX 1% FEED PREMIX [Cyromazine]	POULTRY SHED
52308	LARVADEX 10% FEED PREMIX [Cyromazine]	POULTRY SHED
52444	SOL-U-MOX AMOXYCILLIN SOLUBLE POWDER [Amoxycillin]	POULTRY
52554	ZINC BACITRACIN 150 G/KG POWDER - FEED PREMIX [Zinc Bacitracin]	POULTRY
52621	NEOMYCIN SULPHATE UPJOHN FEED ADDITIVE POWDER [Neomycin]	POULTRY

52782	CCD NEOMYCIN (NEOMYCIN SULPHATE WATER SOLUBLE POWDER) [Neomycin]	POULTRY
52810	CCD D.O.T. 250 PREMIX (DINITRO-O-TOLUAMIDE) [Dinitro-o-toluamide]	PULLET - REPLACEMENT
52812	CCD DMZ 225 PREMIX (DIMETRIDAZOLE) [Dimetridazole]	POULTRY
52854	FARMDYNE IODOPHOR SANITISER [Iodine]	POULTRY SHED
52862	CCD LEVAMISOLE (LEVAMISOLE HYDROCHLORIDE WATER SOLUBLE POWDER) [Levamisole]	POULTRY
52925	CCD OTC 100 PREMIX (OXYTETRACYCLINE) [Oxytetracycline]	POULTRY
52970	CCD VITAMIN C (ASCORBIC ACID WATER SOLUBLE POWDER) [Ascorbic acid]	POULTRY
53099	AVIZYME TYPE 1202 PREMIX FOR WHEAT/BARLEY BASED POULTRY FEED [Enzyme]	POULTRY
53101	AVIZYME TYPE 1502 PREMIX FOR POULTRY FEED [Enzyme]	POULTRY
53128	SELECTOCHEM 3-NITRO FEED ADDITIVE POWDER [Mineral arsenic]	POULTRY
53143	NOBILIS RISMAVAC [Vaccine]	POULTRY
53180	PYCARE NATURAL PYRETHRUM METERED INSECTICIDE [Pyrethrum]	POULTRY SHED
53284	COOPERS SELENIUM DRENCH CONCENTRATE FOR SHEEP, CATTLE AND POULTRY [Selenium]	POULTRY
53304	SALECO 120 ANTICOCCIDIAL FEED ADDITIVE POWDER [Salinomycin]	POULTRY
53314	TETRAVET 980 SOLUBLE ANTIBIOTIC POWDER [Oxytetracycline]	POULTRY
53566	CLEAN AIR PURGE INSECTICIDE WITH 9.75G/KG PYRETHRINS [Piperonyl butoxide, pyrethrins]	POULTRY HOUSE - EGG HANDLING AREA
53567	CLEAN AIR PURGE INSECTICIDE METERED AEROSOL [Piperonyl butoxide, pyrethrins]	POULTRY HOUSE - EGG HANDLING AREA
53575	FLAVOMYCIN 80 MICROFLORA MANAGEMENT SUPPLEMENT [Flavophospholipol]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
53591	HVT-CA VACCINE [Vaccine]	POULTRY
53621	TRIDIAZINE ORAL SUSPENSION WATER MEDICATION [Trimethoprim, sulfadiazine]	POULTRY
53636	CCD AUREOMYCIN (CHLORTETRACYCLINE WATER SOLUBLE POWDER) [Chlortetracycline]	POULTRY
53675	FARMQUAT DISINFECTANT-SANITIZER-DEODORANT [QAC]	POULTRY DRINKING WATER
53753	TYLECO SOLUBLE WATER SOLUBLE TYLOSIN TARTRATE [Tylosin]	PULLET - REPLACEMENT
53811	NOBILIS NEWCAVAC VACCINE AGAINST NEWCASTLE DISEASE IN POULTRY [Vaccine]	POULTRY
53830	SALINDOX 120 BMP MICROGRANULATE FEED ADDITIVE [Salinomycin]	POULTRY CAGED LAYERS
53831	RONOZYME P (CT) [Enzyme]	POULTRY

53832	RONOZYME P (L) [Enzyme]	POULTRY
53977	CCD MULTIVITAMINS (WATER SOLUBLE POWDER) [Vitamins]	POULTRY
54051	KOKCISAN 120G [Salinomycin]	PULLET - REPLACEMENT
54091	AAH NEOMYCIN SULPHATE FEED ADDITIVE POWDER [Neomycin]	POULTRY
54144	LASALOCID TECHNICAL LASALOCID SODIUM [Lasalocid]	PULLET - REPLACEMENT
54186	OXY-ECO BASE [Oxytetracycline]	POULTRY
54232	FLAVECO 40 FEED SUPPLEMENT {Flacophospholipol]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
54248	JUROX MONENSIN 200 FEED ADDITIVE PREMIX [Monensin]	POULTRY
54249	JUROX MONENSIN 100 FEED ADDITIVE PREMIX [Monensin]	POULTRY
54322	TYLOVET TYLOSIN TARTRATE SOLUBLE [Tylosin]	POULTRY
54447	COCCIMYCIN ANTICOCCIDIAL PREMIX [Salinomycin]	POULTRY (SEE LABEL)
54447	COCCIMYCIN ANTICOCCIDIAL PREMIX [Salinomycin]	PULLET-LAYING REPLACEMENT
54495	EIMERIAVAX 4M [Vaccine]	POULTRY
54574	FLAVECO 5 FEED SUPPLEMENT]Flavophospholipol]	POULTRY LAYERS (EGGS FOR HUMAN CONSUMP)
54677	CTC-ECO BASE 200 [Chlortetracycline]	POULTRY
54694	BIOPLUS 2B [Biological organisms]	POULTRY (SEE LABEL)
54695	BIOPLUS 2B CONCENTRATE DXHC [Biological organisms]	POULTRY (SEE LABEL)
54719	PHARMACHLOR CTC CHLORTETRACYCLINE SOLUBLE POWDER [Chlortetracycline]	POULTRY
54765	PINK HEALTHCARE SERVICES METERED INSECTICIDE [Piperonyl butoxide, pyrethrins]	POULTRY SHED
55124	ROVABIO EXCEL PREMIX [Enzyme]	POULTRY
55125	ROVABIO EXCEL L200 [Enzyme]	POULTRY
55149	ROVABIO EXCEL LC [Enzyme]	POULTRY
55222	INGHAM 1B STRAIN VACCINE (LIVE, VIRUS) [Virus]	POULTRY
55527	PHIBROMONENSIN 400 MONENSIN FEED ADDITIVE PREMIX [Monensin]	POULTRY
55528	PHIBROMONENSIN 100 MONENSIN FEED ADDITIVE PREMIX [Monensin]	POULTRY
55596	MONECO 100 FEED ADDITIVE POWDER FOR CATTLE, GOATS AND POULTRY [Monensin]	POULTRY (SEE LABEL)
55849	AGRICON CLAMCIL SOLUBLE POWDER [Amoxycillin]	POULTRY
55871	HAMMERSLEY IODO-CIDE SANITISER [Iodine]	POULTRY SHED
56056	RONOZYME WX (L) [Enzyme]	POULTRY
56060	RONOZYME WX (CT) [Enzyme]	POULTRY

56062	RONOZYME W (CT) [Enzyme]	POULTRY
56063	RONOZYME W (L) [Enzyme]	POULTRY
56065	RONOZYME A (L) [Enzyme]	POULTRY
56067	RONOZYME A (CT) [Enzyme]	POULTRY
56068	RONOZYME VP (CT) [Enzyme]	POULTRY
56069	RONOZYME VP (L) [Enzyme]	POULTRY
56182	PROMOTOR L [Multi vitamins]	POULTRY
56235	TYLO-SOL BMP WATER SOLUBLE MICROGRANULES [Tylosin]	POULTRY
56235	TYLO-SOL BMP WATER SOLUBLE MICROGRANULES [Tylosin]	PULLET - REPLACEMENT
56236	AMOXI-SOL BMP WATER SOLUBLE MICROGRANULES [Amoxycillin]	POULTRY
56273	AVATEC CC LASALOCID SODIUM COCCIDIOCIDAL PREMIX [Lasolocid]	PULLET - REPLACEMENT
56328	ALBAC G 150 ANTIBIOTIC FEED PREMIX [Bacitracin]	POULTRY
56595	AIROMIST METERED INSECTICIDE [Piperonyl butoxide, pyrethrins]	POULTRY SHED
56688	CYCOSTAT 66G COCCIDIOSTAT [Robenidine]	POULTRY
58035	AVIAX CONCENTRATE BROAD SPECTRUM COCCIDIOCIDAL FEED ADDITIVE [Semduramicin]	POULTRY (Not for laying poultry)
32986	Nufarm Fenitrothion 1000 Insecticide [Fenitrothion]	POULTRY (Treatment of litter. Layer birds not to be housed In recently treated sheds)

APPENDIX B

PESTICIDES AND VETERINARY DRUGS (V) LISTED IN THE APVMA RESIDUE STANDARD AND WHERE THE MEAT/EGG ENTRY IS DEFINED AS "IN THE FAT"

Organochlorines eg DDT, chlordane, heptachlor, dieldrin	Doramectin (V)	Imazapic	Permethrin
Bifenthrin	Endosulfan	Imazapyr	Phosmet
Bioresmethrin	Ethion (V)	Indoxacarb	Picolinafen
Bitertanol	Ethofumesate	Iodosulfuran-methyl	Procymidone
Buprofezin	Fenchlorvos (V)	Ivermectin (V)	Propargite
Chlorfenapyr	Fenhexamid	Lufenuron	Propetamphos (V)
Chlorfenvinphos	Fenitrothion	Maldison	Pyriproxyfen
Chlorfluazuron	Fenvalerate	Metalaxyl	Quinoxyfen
Chlorpyrifos	Fipronil	Methidathion	Spinosad
Chlorpyrifos methyl	Fluazuron (V)	Methoprene	Tebufenozide
Coumaphos	Flumethrin (V)	Methoxyfenozide	Toltrazuril (V)
Cyhalothrin	Flupropanate (V)	Moxidectin (V)	Triclopyr
Cypermethrin	Fluquinconazole	ODB (ODB)	Triflumuron
Deltamethrin	Flutolanil	Olaquindox (V)	
Diafenthiuron	Haloxyfop	Oxyfluorfen	
Diazinon			
Diflubenzuron (V)			
Diphenylamine			

APPENDIX C

SUMMARY OF FINDINGS

Pesticides and Veterinary Medicines Used Within the Egg Industry

Chemical	MRL mg/kg	Codex MRL mg/kg	ADI mg/kgbdywt/day	NRS Detections (Eggs)	NRS Violations (eggs)	Total Diet Study Results
Amoxycillin ♠	Not listed	Not listed	0.2	0	0	Not included
Amprolium	4	Not listed	Not listed			Not included
Azimethiphos	*0.05	Not listed	0.003			Not included
Bacitracin	*0.5	Not listed	0			Not included
Carbaryl #	T0.2	0.5	0.008			Detected 0.85% ADI
Chlortetracycline	0.2	Not listed	0.003	0	0	Not included
Cyfluthrin	*0.01	Not listed	0.02			Not detected
Dimetridazole ♥	Not listed	Cannot be set	Withdrawn			Not included
Flavophospholipol	*0.02	Not listed	0.3			Not included
Lasalocid	T*0.05	Not listed	0.001			Not included
Levamisole	1	Not listed	0.003			Not included
Lincomycin	0.2	Not listed	1	0	0	Not included
Maldison	1	Not listed	0.02	0	0	Detected <0.01% ADI
Monensin	Not listed	Not listed	0.01			Not included
Nicarbazin	Not listed	Not listed	2			Not included
Permethrin	0.1	0.1	0.05			Detected 0.03% ADI
Pyrethrum	Exempted	Not listed	0.04			Not included
Piperazine	Not listed	Not listed	Not set			Not included
Salinomycin	*0.02	Not listed	0.01			Not included
Spectinomycin	2	Not listed	1			Not included
Sulfadiazine ♠	Not listed	Not listed	0.02			Not included
Sulfadimidine ♠	Not listed	Not listed	0.02			Not included
Sulfaquinoxaline♠	Not listed	Not listed	0.01			Not included
Tiamulin	Not listed	Not listed	Not set			Not included

Toltrazuril ♠♣	Not listed	Not listed	0.01			Not included
Trimethoprim ♠	Not listed	Not listed	0.02			Not included

Not included = Not included in monitoring program.
Not detected = Specifically determined through analysis and no residue detected.
♠ = Minor Use Permit being considered by APVMA
♣ = Label Restraint Prevents Use
= Currently Under Review
♥ = APVMA has concluded its review and called for public comment on proposed outcome.

Pesticides that Might Carryover into Eggs

Chemical	MRL mg/kg	Codex MRL mg/kg	ADI mg/kgbdywt/day	NRS Detections (Eggs)	NRS Violations (Eggs)	Total Diet Study Results
Aldrin & Dieldrin	E0.1	E0.1	0.0001 (T)	0	0	Not detected
Azamethiphos	*0.05	Not set	0.003	Not reported	Not reported	Not included
Bifenthrin	*0.05	*0.01	0.01	Not reported	Not reported	0.03%
Chlorpyrifos	T*0.01	0.01	0-.003	0	0	0.17%
Chlorpyrifos-methyl	*0.05	0.05	0.01	Not reported	Not reported	0.72%
Cyhalothrin	*0.02	Not set	0.02	Not reported	Not reported	Not detected
Cypermethrin	0.05	0.05	0.05	Not reported	Not reported	Not detected
DDT		0.1	0.002 (T)	0	0	0.03%
Deltamethrin	*0.01	*0.01	0.01	Not reported	Not reported	Not detected
Dichlorvos	0.05	Not set	0.001	Not reported	Not reported	Not detected
Endosulfan	T*0.05	Not set	0.006	0	0	0.04%
Fenitrothion	*0.05	Not set	0.002	Not reported	Not reported	0.54%
Fenvalerate	0.02	Not set	0.02	Not reported	Not reported	Not detected
Fipronil	T0.1	0.02	0.0002	Not reported	Not reported	Not included
HCB	E1	Withdrawn	Not set	0	0	Not detected
Lindane	E0.1	E0.1	0.003	0	0	Not detected
Methoprene	None set	Not set	0.4	Not reported	Not reported	< 0.01%
Piperonyl butoxide	*0.01	*0.01	0.1	Not reported	Not reported	0.07%
Pirimiphos-methyl	*0.05	Withdrawal recommended	0.02	Not reported	Not reported	0.06%
Spinosad	T0.05	0.01	1	Not reported	Not reported	Not included

Not included = not included in monitoring program.
Not detected = Specifically determined through analysis and no residue detected.
% = percentage of ADI based on dietary intake of adult male.

Heavy Metals in Eggs (20th Australian Total Diet Study)

Metal	No of Samples	No nd Samples	Mean Nd=0 mg/kg	Mean Nd=LOR mg/kg	Median mg/kg	Minimum mg/kg	Maximum mg/kg
Antimony	28	28	---------- No Detections ----------				
Arsenic	28	2	0.022	0.023	0.02	nd	0.04
Cadmium	28	28	---------- No Detections ----------				
Copper	28	0	0.641		0.65	0.53	0.82
Lead	28	26	0.001	0.010	nd	nd	0.01
Mercury	28	28	---------- No Detections ----------				
Selenium	28	0	0.284	0.284	0.27	0.18	0.47
Tin	28	0		12.1	12	6.6	21

Polychlorinated Biphenyls (PCBs) in Eggs (National Dioxins Program)

	Mean PCBs (pg TEQ/g lipid)						
	Australia This study	**New Zealand**	**UK**	**Netherlands**	**Europe***	**Asia***	**North America***
Eggs	**0.04-0.11**	**0.05-0.11**	**0.11-0.20**	**0.87**	**0.2-0.6**	**-**	**0.029**
Beef	0.03-0.11	0.0036-0.092	0.25-0.31	1.24	-	-	0.5
Pork	0.04-0.07	0.15-0.43	-	0.23	0.8	-	0.02-1.7
Lamb	0.02-0.06	0.01-0.045	-				
Poultry	0.18-0.24	0.018-0.14	0.47-0.53	1.72	0.7	-	0.3
Fish	9.46-9.5	0.77	3.57-3.57	0.412	0.03-9	0.004-2.0	0.11-0.28
Milk	0.04-0.11	0.027-0.15	0.34-0.43	0.69	0.2-1.8	-	0.5

Comparisons of mean PCB concentrations in selected foods from different areas of the world
See FSANZ Report for full details of comparisons
* Results as reported in Position Paper on Dioxins and Dioxin-like PCBs (CX/FAC 03/32), Codex Committee on Food Additives and Contaminants, 35th Session, March 2003

Dioxins in Eggs (National Dioxins Program)

	Australia This study	New Zealand	UK	Netherlands	Europe*	Asia*	North America*
Eggs	**0.013-0.42**	**0.017-0.12**	**0.24-0.24**	**1.52**	**0.5-2.7**	**-**	**0.044-0.3**
Beef	0.0006-0.24	0-0.11	0.41-0.42	0.82	0.6-1	1.0	0.5-4.1
Pork	0.05-0.22	0-0.20	-	0.24	0.2-1.4	0.8	0.6-23
Lamb	0.004-0.25	0-0.07	-	-	-	-	-
Poultry	0.02-0.53	0.037-0.29	0.13-0.18	1.06	0.6-0.9	0.67	0.03-3.9
Fish	1.56-3.04	0.33-0.41	1.06-1.06	0.181	0.01-8.9	0.002-10.2	0.033-0.53
Milk	0.04-0.23	0.019-0.16	0.46-0.47	0.57	0.3-2.5	0.30-1.8	0.3-0.9

Comparisons of mean PCDD/F concentrations in selected foods from different areas of the world
See FSANZ Report for full details of comparisons
* Results as reported in Position Paper on Dioxins and Dioxin-like PCBs (CX/FAC 03/32), Codex Committee on Food Additives and Contaminants, 35th Session, March 2003

Attachment 14

Risk Rating Inputs for Hazard:Product Scenarios including Assumptions

Table 14.1: Risk ratings of commercially sourced, non-cracked eggs which have undergone no pathogen growth in the yolk cooked to three different regimes

Risk criteria	Scenario 1 Moderate reduction during preparation	Scenario 2 Substantial reduction during preparation	Scenario 3 Reliable elimination during preparation
Dose and severity			
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General
Probability of exposure			
Q3. Frequency of consumption	Weekly	Weekly	Weekly
Q4. Proportion consuming	Most (75%)	Most (75%)	Most (75%)
Q5. Size of population*	Australian	Australian	Australian
Probability of contamination			
Q6. Probability of raw product contaminated*	0.004%, 1/egg	0.004%, 1/egg	0.004%, 1/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil
Q9. Post-process control	Well Controlled	Well Controlled	Well Controlled
Q10. Increase to infective dose*	10,000	10,000	10,000
Q11. Further cooking before eating*	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	$4x10^{-5}$	$4x10^{-8}$	0
Predicted illnesses per annum in selected population	$3.04x10^{-2}$	$3.04x10^{-5}$	0
Risk ranking (0-100)	24 (30)	7 (12)	0

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.2: Risk ratings of commercially sourced, non-cracked eggs which have undergone pathogen growth in the yolk cooked to three different regimes

Risk criteria	Scenario 4 Moderate reduction during preparation	Scenario 5 Substantial reduction during preparation	Scenario 6 Reliable elimination during preparation
Dose and severity			
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General
Probability of exposure			
Q3. Frequency of consumption	Monthly	Monthly	Monthly
Q4. Proportion consuming	Most	Most	Most
Q5. Size of population*	Australian	Australian	Australian
Probability of contamination			
Q6. Probability of raw product contaminated*	0.004%, 1/egg	0.004%, 1/egg	0.004%, 1/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil
Q9. Post-process control	100,000x increase	100,000x increase	100,000x increase
Q10. Increase to infective dose*	10,000	10,000	10,000
Q11. Further cooking before eating*	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	4	$4x10^{-3}$	0
Predicted illnesses per annum in selected population	$7.02x10^{2}$	$7.02x10^{-1}$	0
Risk ranking (0-100)	49 (54)	32 (37)	0

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.3: Risk ratings of non-commercially sourced, uncracked eggs which have undergone no pathogen growth in the yolk cooked to three different regimes

Risk criteria	Scenario 7 Moderate reduction during preparation	Scenario 8 Substantial reduction during preparation	Scenario 9 Reliable elimination during preparation
Dose and severity			
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General
Probability of exposure			
Q3. Frequency of consumption	Weekly	Weekly	Weekly
Q4. Proportion consuming	Most (75%)	Most (75%)	Most (75%)
Q5. Size of population	2,000,000	2,000,000	2,000,000
Probability of contamination			
Q6. Probability of raw product contaminated*	0.004%, 1/egg	0.004%, 1/egg	0.004%, 1/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil
Q9. Post-process control	Well Controlled	Well Controlled	Well Controlled
Q10. Increase to infective dose*	10,000	10,000	10,000
Q11. Further cooking before eating*	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	$4x10^{-5}$	$4x10^{-8}$	0
Predicted illnesses per annum in selected population	$3.12x10^{-3}$	$3.12x10^{-6}$	0
Risk ranking (0-100)	24 (30)	7 (12)	0 (0)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.4: Risk ratings of non-commercially sourced, uncracked eggs which have undergone pathogen growth in the yolk cooked to three different regimes

Risk criteria	Scenario 10 Moderate reduction during preparation	Scenario 11 Substantial reduction during preparation	Scenario 12 Reliable elimination during preparation
Dose and severity			
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General
Probability of exposure			
Q3. Frequency of consumption	Monthly	Monthly	Monthly
Q4. Proportion consuming	Most (75%)	Most (75%)	Most (75%)
Q5. Size of population	2,000,000	2,000,000	2,000,000
Probability of contamination			
Q6. Probability of raw product contaminated*	0.004%, 1/egg	0.004%, 1/egg	0.004%, 1/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil
Q9. Post-process control	100,000x increase	100,000x increase	100,000x increase
Q10. Increase to infective dose*	10,000	10,000	10,000
Q11. Further cooking before eating*	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	4	$4x10^{-3}$	0
Predicted illnesses per annum in selected population	$7.20x10^{1}$	$7.20x10^{-2}$	0
Risk ranking (0-100)	49 (54)	32 (37)	0 (0)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.5: Risk ratings of non-commercially sourced, cracked eggs which have undergone no pathogen growth in the yolk cooked to three different regimes

Risk criteria	Scenario 13 Moderate reduction during preparation	Scenario 14 Substantial reduction during preparation	Scenario 15 Reliable elimination during preparation
Dose and severity			
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General
Probability of exposure			
Q3. Frequency of consumption	Few times	Few times	Few times
Q4. Proportion consuming	Very few	Very few	Very few
Q5. Size of population	2,000,000	2,000,000	2,000,000
Probability of contamination			
Q6. Probability of raw product contaminated	0.04%, 10/egg	0.04%, 10/egg	0.04%, 10/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil
Q9. Post-process control	Well Controlled	Well Controlled	Well Controlled
Q10. Increase to infective dose*	1,000	1,000	1,000
Q11. Further cooking before eating*	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	4.0×10^{-3}	4.0×10^{-6}	0
Predicted illnesses per annum in selected population	1.20×10^{-3}	1.20×10^{-6}	0
Risk ranking (0-100)	22 (27)	0 (10)	0 (0)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.6: Risk ratings of non-commercially sourced, cracked eggs which have undergone pathogen growth in the yolk cooked to three different regimes

Risk criteria	Scenario 16 Moderate reduction during preparation	Scenario 17 Substantial reduction during preparation	Scenario 18 Reliable elimination during preparation
Dose and severity			
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General
Probability of exposure			
Q3. Frequency of consumption	Every few years	Every few years	Every few years
Q4. Proportion consuming	Some	Some	Very few
Q5. Size of population	2,000,000	2,000,000	2,000,000
Probability of contamination			
Q6. Probability of raw product contaminated	0.04%, 10/egg	0.04%, 10/egg	0.04%, 10/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil
Q9. Post-process control	100,000x increase	100,000x increase	100,000x increase
Q10. Increase to infective dose*	1,000	1,000	1,000
Q11. Further cooking before eating*	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	$4.00x10^{2}$	$4.00x10^{-1}$	0
Predicted illnesses per annum in selected population	$6.00x10^{1}$	$6.00x10^{-2}$	0
Risk ranking (0-100)	48 (54)	31 (37)	0

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.7: Risk ratings of commercially sourced eggs used for raw egg drinks

Risk criteria	Scenario 19 Commercially sourced Not cracked No yolk growth	Scenario 20 Commercially sourced Not cracked Yolk growth	Scenario 21 Non-commercially sourced Not cracked No yolk growth	Scenario 22 Non-commercially sourced Not cracked Yolk growth	Scenario 23 Non-Commercially sourced Cracked No yolk growth	Scenario 24 Non-Commercially sourced Cracked Yolk growth
Dose and severity						
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General	General	General	General
Probability of exposure						
Q3. Frequency of consumption	Monthly	A few times a year	Monthly	A few times a year	Once every few years	Once every few years
Q4. Proportion consuming	Some (25%)	Some (25%)	Most (75%)	Most (75%)	Very few (5%)	Very few (5%)
Q5. Size of population*	Australian	Australian	2,000,000	2,000,000	2,000,000	2,000,000
Probability of contamination						
Q6. Probability of raw product contaminated*	0.004%, 1/egg	0.004%, 1/egg	0.004%, 1/egg	0.004%, 1/egg	0.04%, 10/egg	0.04%, 10/egg
Q7. Effect of processing*	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)	No effect (washing etc)
Q8. Possibility of recontamination	Nil	Nil	Nil	Nil	Nil	Nil
Q9. Post-process control	Well controlled	100,000x increase	Well controlled	100,000x increase	Well controlled	100,000x increase
Q10. Increase to infective dose*	10,000x increase	10,000x increase	10,000x increase	10,000x increase	1,000x increase	1.000x increase
Q11. Further cooking before eating*	No effect	No effect	No effect	No effect	No effect	No effect
Predicted illnesses per million servings	$4.00x10^{-3}$	$4.00x10^{1}$	$4.00x10^{-3}$	$4.00x10^{1}$	$4.00x10^{-1}$	$4.00x10^{2}$
Predicted illnesses per annum in selected population	$2.34x10^{-1}$	$5.85x10^{2}$	$7.20x10^{-2}$	$1.80x10^{2}$	$1.20x10^{-2}$	$1.20x10^{1}$
Risk ranking (0-100)	29 (35)	48 (54)	32 (37)	51 (57)	27 (33)	44 (50)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.8: Risk ratings of unpasteurised egg pulp used for manufacture of egg puddings and of non-commercial, cracked eggs used as egg butter

Risk criteria	Scenario 25 Non-commercial Cracked eggs Food service sector Egg butter on rolls[8]
Dose and severity	
Q1. Hazard severity	Mild (Moderate)
Q2. Susceptibility	General
Probability of exposure	
Q3. Frequency of consumption	A few times a year
Q4. Proportion consuming	Most (75%)
Q5. Size of population	10,000
Probability of contamination	
Q6. Probability of raw product contaminated	0.04%, 10/egg
Q7. Effect of processing	No effect (mixing with butter)
Q8. Possibility of recontamination	Nil
Q9. Post-process control	Gross abuse (3 log increase)
Q10. Increase to infective dose*	1,000x increase
Q11. Further cooking before eating*	No effect
Predicted illnesses per million servings	4
Predicted illnesses per annum in selected population	9
Risk ranking (0-100)	57 (62)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

[8] Hypothetical Scenario 25 can be considered a sub-set of Scenario 23; cracked eggs from non-commercial production systems with no pathogen growth within the egg. As a result the population size considered in this scenario is much smaller than for Scenario 23.

Table 14.9: Risk ratings and predicted illnesses from consumption of egg based meals prepared from unpasteurised egg pulp which have undergone various pathogen reduction regimes

Risk criteria	Scenario 26 No reduction during preparation	Scenario 27 Moderate reduction during preparation	Scenario 28 Substantial reduction during preparation	Scenario 29 Reliable elimination during preparation
Dose and severity				
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General	General
Probability of exposure				
Q3. Frequency of consumption	Few years	Monthly	Few times	Few times
Q4. Proportion consuming	All (100%)	Very few (5%)	Some (25%)	Most (75%)
Q5. Size of population	130,000	130,000	130,000	130,000
Probability of contamination				
Q6. Probability of raw product contaminated	25%, 0.1/g	25%, 0.1/g	25%, 0.1/g	25%, 0.1/g
Q7. Effect of processing*	No effect	No effect	No effect	No effect
Q8. Possibility of recontamination	Nil	Nil	Nil	Nil
Q9. Post-process control	Not controlled (1 log increase)	Not controlled (1 log increase)	Not controlled (1 log increase)	Not controlled (1 log increase)
Q10. Increase to infective dose*	10,000x increase	10,000x increase	10,000x increase	10,000x increase
Q11. Further cooking before eating*	No effect	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	$2.50x10^{2}$	$2.5x10^{0}$	$2.50x10^{-3}$	0
Predicted illnesses per annum in selected population	$9.75x10^{0}$	$1.95x10^{-1}$	$2.44x10^{-4}$	0
Risk ranking (0-100)	51 (56)	41 (47)	24 (30)	0 (0)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Table 14.10: Risk ratings and predicted illnesses from consumption of egg based meals prepared from pasteurised egg pulp which have undergone various pathogen reduction regimes

Risk criteria	Scenario 30 No reduction during preparation	Scenario 31 Moderate reduction during preparation	Scenario 32 Substantial reduction during preparation	Scenario 33 Reliable elimination during preparation
Dose and severity				
Q1. Hazard severity	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)	Mild (Moderate)
Q2. Susceptibility	General	General	General	General
Probability of exposure				
Q3. Frequency of consumption	Few times	Few times	Few years	Monthly
Q4. Proportion consuming	Most (75%)	All	All	Most (75%)
Q5. Size of population*	Australian	Australian	Australian	Australian
Probability of contamination				
Q6. Probability of raw product contaminated	25%, 0.1/g	25%, 0.1/g	25%, 0.1/g	25%, 0.1/g
Q7. Effect of processing*	Reliably eliminates	Reliably eliminates	Reliably eliminates	Reliably eliminates
Q8. Possibility of recontamination	0.2%	0.2%	0.2%	0.2%
Q9. Post-process control	Well controlled	Well controlled	Well controlled	Well controlled
Q10. Increase to infective dose*	10,000x increase	10,000x increase	10,000x increase	10,000x increase
Q11. Further cooking before eating*	No effect	Moderate reduction (99%)	Substantial reduction (99.999%)	Reliable elimination (>99.999999%)
Predicted illnesses per million servings	0.2	2.00×10^{-3}	2×10^{-6}	0
Predicted illnesses per annum in selected population	8.78	1.17×10^{-1}	1.17×10^{-4}	0
Risk ranking (0-100)	38 (44)	27 (33)	10 (16)	0 (0)

A change in risk ranking of "6" is equivalent to a 10-fold change in risk * answers to these questions based on data. Questions without * are based on assumptions.

Commercial shell eggs cracked after packing – "based on assumptions"

An additional scenario was developed for eggs that are cracked after packing.

We assume the following:

- Egg trays and cartons are clean and pathogen-free
- Eggs have been washed, dried, candled and graded prior to packing
- Proportion of cracked eggs in cartons assumed to be 1% (Industry estimate)
- Proportion of *Salmonella* on egg shells after washing is 0.06% (upper 95% confidence interval, SARDI unpublished data)
- Half of all cracked eggs will be discarded prior to food preparation
- Only 1% of shell contaminated eggs cracked after packing will become internally contaminated with *Salmonella*
- Median infective dose, ID_{50} for *Salmonella* is taken as 10,000 cells.

A major uncertainty is the ability of *Salmonella* cells to pass from the shell into the contents after cracking. Handling and environmental conditions, eg sweating of cold eggs moved into warm, humid conditions will influence the movement of *Salmonella*.

Using the assumed inputs suggested above, the prevalence of internally contaminated eggs can be calculated:

Prevalence of eggs contaminated from shells to contents =

proportion of eggs cracked after packing x

proportion of cracked eggs not discarded x

proportion of contaminated shells x

proportion of eggs internally contaminated from shells

Therefore, the prevalence of eggs contaminated from shells to contents can be calculated as 0.01 x 0.5 x 0.0006 x 0.01 = $3x10^{-8}$.

Number of Salmonella cells in cracked eggs

To be consistent with non-commercial cracked eggs it is assumed that initial number of cells in the egg contents is 1/g. This ignores the reduction in *Salmonella* numbers on the shell due to washing and desiccation.

Number of internally contaminated eggs due to post-packing cracks

As with other shell eggs it is assumed that 75% of cracked contaminated eggs will be consumed or refrigerated prior to the expiry of the YMT. The remaining 25% of eggs will experience yolk invasion with subsequent growth to high numbers.

Total number of shell eggs per year = 176 million dozen = $2.112x10^{9}$ eggs

Cracked eggs with no *Salmonella* growth in contents = $176mx12x0.75x3x10^{-8}$ = 47.52 eggs per year
Cracked eggs with *Salmonella* growth in contents = $176mx12x0.25x3x10^{-8}$ = 15.84 eggs per year

Estimated number of *Salmonella* contaminated eggs due to cracking after packing that are consumed or refrigerated prior to the expiry of the YMT by preparation effect

Preparation effect	Calculation	Estimated number of eggs per year
NE	47.52 x 0.075	3.56
MR	47.52 x 0.275	13.08
SR	47.52 x 0.325	15.44
RE	47.52 x 0.325	15.44

Estimated number of *Salmonella* contaminated eggs due to cracking after packing that are consumed or refrigerated after the expiry of the YMT by preparation effect

Preparation effect	Calculation	Estimated number of eggs per year
NE	15.84 x 0.075	1.188
MR	15.84 x 0.275	4.356
SR	15.84 x 0.325	5.148
RE	15.84 x 0.325	5.148

Predicted cases of illness per year

For eggs where internal growth has not occurred, the initial number of *Salmonella* cells prior to preparation is 50 cells. Where growth has occurred, an increase of 100,000 times the initial number is assumed; the number prior to preparation is $5x10^6$ cells.

Preparation effect	Yolk growth	Dose (cells)	Probability of illness	Predicted number of illnesses per year
NE	No	$5x10^1$	10^{-4}	$3.56x10^{-4}$
MR	No	$5x10^{-1}$	10^{-6}	$1.31x10^{-5}$
SR	No	$5x10^{-4}$	10^{-9}	$1.54x10^{-8}$
RE	No	0	0	0
NE	Yes	$5x10^6$	1	1.188
MR	Yes	$5x10^4$	10^{-1}	0.436
SR	Yes	$5x10^1$	10^{-4}	$5.15x10^{-4}$
RE	Yes	0	0	0

The estimate of the total number of cases per year from cracked eggs post-packing is less than 2. The total number of commercially sourced eggs produced per year is greater than 2 billion.

Attachment 15

Controls and Potential Controls

Current Systems

1. FSANZ Food Standards (FSANZ 2004b)

Standard 2.2.2 Egg and Egg Products

Purpose
This Standard provides definitions for egg and egg products. Processing requirements for egg products and requirements relating to the sale of cracked eggs are included in this Standard and Standard 1.6.2.

Table of Provisions
1 Interpretation
2 Processing of egg products
3 Sale of cracked eggs

Clauses
1 Interpretation
In this Code –
egg means the reproductive body in shells obtained from any avian species, the shell being free from visible cracks, faecal matter, soil or other foreign matter.
egg products means the content of egg, as part or whole, in liquid, frozen or dried form.
visible cracks includes cracks visible by candling.

2 Processing of egg products
(1) Subject to subclause (2), egg products must be pasteurised or undergo an equivalent treatment so that the egg product meets the microbiological criteria specified in Standard 1.6.1.

(2) Subclause (1) does not apply to the non-retail sale of egg products used in a food which is pasteurised or undergoes an equivalent treatment so that the egg product used in the food meets the microbiological criteria specified in Standard 1.6.1.

3 Sale of cracked eggs
(1) Cracked eggs must not be made available for retail sale or for catering purposes.

(2) Egg products derived from cracked eggs sold -
(a) not for retail sale; or
(b) not for catering purposes;
must be pasteurised or have undergone an equivalent treatment so that the egg product meets the microbiological criteria specified in Standard 1.6.1.

Editorial Note:
Standard 1.2.3 requires unpasteurised egg and egg products to be labelled with an advisory statement that the product is unpasteurised

Standard 1.6.1 Microbiological Limits for Food

This Standard lists the maximum permissible levels of foodborne micro-organisms that pose a risk to human health in nominated foods, or classes of foods. This Standard includes mandatory sampling plans, used to sample lots or consignments of nominated foods or classes of foods, and the criteria for

determining when a lot or consignment of food poses a risk to human health and therefore should not be offered for sale, or further used in the preparation of food for sale. The microbiological standards included in the Schedule to this Standard are applicable to the foods listed in the Schedule.

In this Standard -

n means the minimum number of sample units which must be examined from a lot of food as specified in Column 3 of the Schedule in this Standard.

c means the maximum allowable number of defective sample units as specified in Column 4 of the Schedule.

m means the acceptable microbiological level in a sample unit as specified in Column 5 of the Schedule.

M means the level specified in Column 6 of the Schedule, when exceeded in one or more samples would cause the lot to be rejected.

defective sample unit means a sample unit in which a micro-organism is detected in a sample unit of a food at a level greater than m.

food means a food product listed in Column 1 of the Schedule.

micro-organism means a microbiological agent listed in Column 2 of the Schedule.

SPC means standard plate count at 30°C with an incubation time of 72 hours.

Microbiological limits in food

A lot of a food fails to comply with this Standard if the -

(a) number of defective sample units is greater than c; or

(b) level of a micro-organism in a food in any one of the sample units exceeds M.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Food	**Micro-organism**	**n**	**c**	**m**	**M**
Pasteurised egg products	*Salmonella*/25 g	5	0	0	

Standard 1.6.2 Processing Requirements

This Standard sets out the requirements for processing of foods regulated in Chapter 2 of this Code. This Standard does not apply to food produced in, or imported into, New Zealand.

3 Processing of egg products

(1) In this clause -

liquid egg white means the white of egg separated as efficiently as practicable from the yolk in liquid form.

liquid egg yolk means the yolk of egg separated as efficiently as practicable from the white in liquid form.

liquid whole egg means the whole egg removed from the shell and includes the product which is frozen or chilled, but does not include reconstituted dried egg.

(2) Liquid whole egg or a mixture of liquid egg yolk and liquid egg white must not be sold or used in the manufacture of food unless it has been pasteurised by being retained at a temperature not lower than 64°C for at least 2.5 minutes and immediately rapidly cooled to a temperature not greater than 7°C.

(3) Liquid egg yolk must not be sold or used in the manufacture of food unless it has been pasteurised by being retained at a temperature not lower than 60°C for at least 3.5 minutes and immediately rapidly cooled to a temperature not greater than 7°C.

(4) Subject to subclause 2(2) of Standard 2.2.2, liquid egg white must not be sold or used in the manufacture of food unless it has been pasteurised by being retained at a temperature not lower than 55°C for at least 9.5 minutes and immediately rapidly cooled to a temperature not greater than 7°C.

Editorial note:
From raw material production to the point of consumption, egg products and products containing egg products should be subject to a combination of control measures, including, for example, pasteurisation, and such measures should be shown to achieve the appropriate level of public health protection.

Standard 1.2.3 Mandatory Warnings and Advisory Statements and Declarations

This Standard sets out mandatory advisory statements and declarations which must be made in relation to certain foods or foods containing certain substances.

2 Mandatory advisory statements and declarations

(1) The label on a package of food listed in column 1 of the Table to this clause must include the advisory statement listed in relation to that food in column 2 of the Table.

(2) Where a food listed in column 1 of the Table to this clause is not required to bear a label pursuant to clause 2 of Standard 1.2.1, the advisory statement listed in relation to that food in column 2 of the Table, must be –

(a) displayed on or in connection with the display of the food; or
(b) provided to the purchaser upon request.

Editorial note:
Paragraph 2(2)(b) allows the retailer of a food to provide the information specified in the Table to clause 2 verbally or in writing.

Column 1	Column 2
Food	**Advisory Statement**
Unpasteurised egg products	Statement to the effect that the product is unpasteurised

4 Mandatory declaration of certain substances in food

(1) The presence in a food of any of the substances listed in the Table to this clause, must be declared in accordance with subclause (2), when present as -

(a) an ingredient; or
(b) an ingredient of a compound ingredient; or
(c) a food additive or component of a food additive; or
(d) a processing aid or component of a processing aid.

(2) Any substances required to be declared by subclause (1) must be –

(a) declared on the label on a package of the food; or
(b) where the food is not required to bear a label pursuant to clause 2 of Standard 1.2.1 -
    (i) displayed on or in connection with the display of the food; or
    (ii) provided to the purchaser upon request.

Editorial note:
Paragraph 4(2)(b) allows the retailer of a food to provide the information specified in the Table to clause 2 verbally or in writing.

Table to clause 4

Egg and egg products

Editorial note:

1. Clause 4 can be complied with by listing those substances in the Table in the ingredient list.
2. Any exemptions in relation to ingredient listing do not override the requirement to declare the presence of the substances listed in the Table to clause 4.
3. Manufacturers occasionally substitute one ingredient for another within the same class of foods. Where this involves a substance listed in the Table to clause 4 there must be an indication on the label that the substance is in the food. Manufacturers may indicate in the ingredient list that the product contains one substance or another (e.g. brazil nuts or cashew nuts) in cases where substitutions occur regularly.
4. Expressions such as 'egg and egg product' or 'crustacea and their products' include all products derived from the substance listed in the Table to clause 4.
5. Sulphites should be declared in the same manner as other food additives.
6. Coconut is the fruit of the palm (*Cocos nucifera*) and is not generally considered to be a tree nut.

2. Codes of Practice

Code of Practice for Shell Egg, Production, Grading, Packing and Distribution

This Code of Practice provides guidance on the hygienic production, storage, packaging and distribution of shell eggs intended for human consumption and sets the minimum standards of hygiene. It is expected that these standards will be met.

The Code aims to prevent contamination and deterioration in the quality of shell eggs and has been designed to cover different types of egg production systems from small free range farms to intensive cage systems.

The Code also reflects and supports existing Commonwealth, State and Territory food safety related legislation. Because the legislation reflects minimum standards, where it is considered appropriate and in the public interest, this Code proposes higher standards. AEIA expects members to abide by this Code.

Although most poultry diseases do not affect humans, to ensure the production of a safe product, it is expected that egg producers will only obtain healthy and disease free birds, wherever possible. It is expected that packers will only receive eggs from producers who comply with the Code. It is expected that packers will ensure that instructions for the hygienic storage of eggs are passed on to their retailer/caterer customers and to the final consumer.

Code of Practice for the Manufacture of Egg Products

Egg products in liquid, frozen and dried forms are used as ingredients in many food products. This Code of Practice provides guidance on the hygienic production, storage, packaging and distribution of egg products intended for human consumption and sets the minimum standards of hygiene. It is expected that these standards will be met.

The Code aims to prevent contamination and deterioration in the quality of egg products and has been designed to cover all different types of egg product manufacturing. The Code is a flexible document and recognises the difficulties some manufacturers may have in hygiene control.

The Code also reflects and supports existing Commonwealth, State and Territory food safety related legislation. Because the legislation reflects minimum standards, where it is considered appropriate and in the public interest, this Code proposes higher standards. AEIA expects members to abide by this Code.

Although most poultry diseases do not affect humans, to ensure the manufacture of a safe product, it is expected that egg product manufacturers will only obtain good quality eggs from farms which comply

with the *Code of Practice for Shell Egg Production, Grading, Packing and Distribution*. It is expected that manufacturers will ensure that instructions for the safe storage and handling of egg products are passed on to their relative retailer/caterer customers and to the final consumer.

Code of Practice for Biosecurity in the Egg Industry

This Code aims to assist the Australian egg industry to understand the issues related to biosecurity and to develop effective biosecurity plans to minimise the occurrence and impact of disease outbreaks. The Code has been developed using HACCP principles to facilitate the incorporation of biosecurity measures into farm quality assurance programs.

Information is given in the Code that will enable producers to develop a Biosecurity Plan for their started pullet or egg producing farms based on defined risks to their farms. While there may be some commonality between Plans developed for different farms, a Plan developed for a cage layer farm is likely to differ from that for a free-range farm and Plans developed by producers in the Sydney area may differ from those in WA, for example.

A set of Good Management Practices can be compiled for a farm from the HACCP-based Biosecurity Plan and can form the "Biosecurity Policy" for the farm.

The outcome of developing a Biosecurity Plan using HACCP principles is that there will be greater assurance that commercial egg industry flocks are protected against serious disease outbreaks. The format developed in this Code could be used to include bird welfare, food safety and egg labelling parameters when developing a National Quality Assurance Programme.

The critical monitoring points identified in this Code are:

- entry of chicks, litter, equipment, vehicles, people and feed into started pullet farms
- entry of litter, started pullets, adult fowls, equipment, vehicles, people and feed into egg production farms
- the presence of wild birds and rodents in sheds or where hens and pullets range
- water sanitation on farms using surface water for internal shed fogging or bird drinking water and disposal systems for dead birds, reject eggs and manure from the farm
- the presence of non-poultry bird species, other poultry and pigs on the farm

National Egg Industry Quality Assurance Program (NEQAP)

The National Egg Quality Assurance Program addresses food safety, biosecurity and animal welfare and product labelling issues.

The scope of the Program is for farm activities from receipt of feed and birds to dispatch of eggs and birds from the farm. For the purposes of this Program a "farm" is defined as a parcel of land with defined boundaries, whether fenced or otherwise, that enables the farmer to establish an effective biosecurity zone around the areas that house the hens or pullets that minimises the risk of disease organisms being brought into contact with the birds. The actual area designated as "the farm" must be defined in each case when implementing the Program.

3. NSW Monitoring and Accreditation Scheme

NSW Agriculture currently manages the SE Monitoring and Accreditation Scheme for layer and breeder flocks in New South Wales (Anon 1999). This scheme is based on the use of drag-swabs, with usually about five swabs collected per shed and cultured in pools of up to five swabs/pool. For a "Monitored" status, flocks must be tested on a monthly basis with negative results. "Accredited" status requires implementation of additional biosecurity and risk-management measures, and "Accredited" flocks may progress to three-monthly testing, subject to certain conditions. For breeder farms,

individual sheds are being sampled and treated under the scheme separately, as individual flocks, although this is not a specific requirement.

Assuming an average of 10-15 swabs per layer flock and five swabs per breeder shed, and that one swab is equivalent to culture or serology on 50 birds (Kingston 1981), this sampling regime provides 95% confidence of detecting a within-flock prevalence of about 0.5% in layer flocks and about 1% in a breeder shed". This is the approach that has been recommended to AECL as the preferred method for the proposed national SE monitoring program (Sergeant *et al* 2003), "a standard higher than that recommended in the International Animal Health Code of the World Animal Health Organisation (Office International des Epizooties)". Results for the detection of non-*Salmonella* Enteritidis over a 3 year period is provided in Attachment 9.

4. Washing Table Eggs

Contamination of eggs may occur by vertical and horizontal routes. In the latter situation, contaminants from faecal material and dust move through the cuticle and shell before ultimately colonising the membranes and yolk (Sparks 1985; Sparks and Broad 1985; Bruce & Drysdale 1994). Surveys of shell egg surfaces overseas for salmonellae indicate a *Salmonella* prevalence of approximately 0.2% (Attachment 6). While similar comprehensive data is not available in Australia, a pilot survey conducted in 2002 of ungraded and washed eggs found 0% contaminated for each category; the upper 95% confidence limit was 0.2% and 0.06% respectively (Attachment 6). These figures reflect the low prevalence found overseas.

In relation to removing surface contaminants the implementation of egg washing is variable. Current European Union legislation prohibits the washing of class A eggs, while in the USA, Japan and Australia egg-washing technology has been embraced.

A comprehensive review of the scientific and engineering issues determining the efficacy of egg washing has recently been reviewed (Hutchinson *et al* 2003). The authors conclude that egg washing reduces the number of micro-organisms on the shell surface and can also remove food poisoning organisms. They observe however, that there are few reports of the microbiological status of eggs that have been washed under commercial conditions. They suggest that given the advances in the technology associated with egg washing machines and that many of the current recommendations are based on data generated from machines that predate the current technology by several generations it is arguably appropriate to re-evaluate the processing criteria for egg washing machines. The proponents also point to the low incidence of food poisoning linked with washed eggs. Additional useful data on the efficacy of various chemicals used for washing eggs is provided by Wang and Slavik (1997). It was reported that quaternary ammonium compounds and sodium hypochlorite used at 100ppm resulted in microbiologically clean eggs and did not destroy eggshell surfaces (i.e. cuticle defences), which protect eggs from further bacterial recontamination.

The utilisation of egg washing was surveyed among Australian egg processors in 2002 and revealed the majority wash eggs at temperatures between 39-43^{0}C. Details of QA compliance with regard to appropriate use of chemicals used and maintenance of pH were not recorded to provide an indication of processing efficiency on bacterial counts or potential for increased penetration by *Salmonella* (Ostlund 1971a; Ostlund 1971b). This is an area of uncertainty and might be considered as an area for further risk analysis (Objective 4).

5. Pasteurisation of Liquid Egg

Liquid egg pasteurisation specifications were surveyed in 8 processors in 6 states of Australia in 2002. Results for whole liquid egg, yolk and albumen are reported in Tables 15.2, 15.2 and 15.3. The current FSANZ Standard is reported in Table 15.4.

Table 15.1: Reported temperatures and holding times for whole liquid egg pasteurisation by Australian processors

Processor	Holding time (minutes)			Holding temperature (°C)		
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum
1	2.5	2.5	3	64	64	67
2	2.5	2.5	3	64	64.5	65
3	2.5	2.5	3	64.5	65	65.5
4	2.5	3.5	5	60	62	64
5	2.5	2.5	3	64	64	64
6	n/a	n/a	n/a	n/a	n/a	n/a
7	3	3	3.5	64	64.5	65
8	2.8	2.9	3	64	64.5	64.5

Table 15.2: Reported temperatures and holding times for yolk pasteurisation by Australian processors

Processor	Holding time (minutes)			Holding temperature (°C)		
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum
1	3.5	3.5	3.5	60	61	62
2	3.5	3.5	3.5	60	61	62
3	n/a	n/a	n/a	n/a	n/a	n/a
4	n/a	n/a	n/a	n/a	n/a	n/a
5	3.5	3.5	3.5	60	60	60
6	n/a	n/a	n/a	n/a	n/a	n/a
7	n/a	n/a	n/a	n/a	n/a	n/a
8	n/a	n/a	n/a	n/a	n/a	n/a

Table 15.3: Reported temperatures and holding times for albumen pasteurisation by Australian processors

Processor	Holding time (minutes)			Holding temperature (°C)		
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum
1	9.5	9.5	9.5	54	55	55
2	n/a	n/a	n/a	n/a	n/a	n/a
3	n/a	n/a	n/a	n/a	n/a	n/a
4	3.5	7.5	9.5	55	55	55
5	9.5	10	10	55	55.5	55.5
6	n/a	n/a	n/a	n/a	n/a	n/a
7	n/a	n/a	n/a	n/a	n/a	n/a
8	n/a	n/a	n/a	n/a	n/a	n/a

Table 15.4: FSANZ minimum processing time and temperature requirements for egg product pasteurisation

Product	Holding time (minutes)	Holding temperature (°C)
Whole liquid egg	2.5	64
Yolk	3.5	60
Albumen	9.5	55

Potential Mitigations

1. *Salmonella enteritidis* surveillance and response options for the Australian egg industry

Source: A report for the Rural Industries Research and Development Corporation (2003) by ESG Sergeant, TM Grimes, CAW Jackson, FC Baldock and IF Wha

The principle goal of a national SE policy should be the protection of human health by preventing the production and sale of SE-infected eggs in Australia. It is also important to provide consumers and markets with assurance that Australian eggs are free of SE, to have an internationally credible surveillance program for the early detection of incidents, and to have contingency plans in place to support a rapid response to incidents.

This publication develops a proposed standard for SE surveillance in Australia, with the dual objectives of the early detection of infected flocks and ongoing demonstration of industry freedom. Testing options for SE were reviewed and a cost-effective surveillance program proposed that provides a high level of confidence of early detection of infected flocks. Options for containment and eradication in infected flocks were also considered, and the development of a national response plan based on these options is proposed.

Full implementation of the recommendations in this report will depend on extensive consultation between the AEIA, layer-breeder companies, egg producer representatives, Animal Health Australia and Governments to develop a truly national approach to SE preparedness and response in Australia.

General recommendations have been made under the major headings listed below with details provided in the body of the report.

Biosecurity
Effective biosecurity should be largely addressed through a number of existing initiatives:

- a new national cost-sharing agreement between Governments and industries for emergency disease responses which includes a general commitment to improved biosecurity by industry signatories;
- the National Egg Quality Assurance Program (2002) for layer flocks;
- the Code of Practice for Biosecurity in the Egg Industry and the Code of Practice for the Shell Egg, Production, Grading, Packing and Distribution; and
- existing company biosecurity programs for breeder flocks.

However, existing company programs for breeder flocks may need to be upgraded for individual sheds to qualify as flocks under the proposed national program.

Surveillance
A national surveillance program should be developed to confirm that biosecurity arrangements are working and as an early-warning safeguard in the event that biosecurity is breached.

The recommended technical standard for SE surveillance in Australia should provide 95% confidence of detecting infection if it were present in 1% of layer flocks (equivalent to three flocks) at a bird prevalence of 0.5%. This standard is higher than that recommended in the *International* prevalence of 0.5% of birds (5 in 1,000 birds infected), or in a single breeder flock at the same *Animal Health* Code of the World Animal Health Organisation (Office International des Epizooties) and those adopted in endemic countries as they are considered inadequate for Australia's purposes where there is a substantial economic benefit from early detection of infection.

The most cost-effective surveillance program should include the following requirements:

For breeder and layer flocks:

- close to 100% compliance by producers;
- approved biosecurity arrangements in place for each participating flock;
- testing at 3-monthly intervals;
- testing based on use of drag-swabs at a rate of 12 swabs per flock, cultured in three pools of four swabs each.

Additional requirements for breeder flocks:

- each farm may be treated as multiple flocks depending on internal biosecurity arrangements;
- testing begins at >18 weeks of age but before 50% production and before eggs are used for hatching.

Additional requirements for layer flocks:

- each farm may be treated as a single flock regardless of the number of sheds;
- testing begins once birds are placed into layer sheds.

Alternative surveillance options for the layer industry

Alternative surveillance options for the layer industry, including the OIE standard, were also considered.

Response plans

SE should be treated as an emergency disease agent and response plans developed through existing mechanisms. This will require development of an AUSVETPLAN disease strategy manual. The proposed key response principles should be as follows:

- confirmation of infection (or lack of infection) in suspected flocks by intensive investigation of birds;
- rapid containment and protection of consumers and other flocks through quarantine, enhanced biosecurity and diversion of eggs to pasteurisation for infected or suspected infected breeder and layer flocks;
- investigation of likely sources and potential spread to other flocks;
- n the case of minor outbreaks, rapid depopulation followed by cleaning and disinfection of sheds and equipment;
- in the case of larger outbreaks, use of vaccine as an interim control measure, followed by depopulation and cleaning/disinfection at a later date, but earlier than usual; and • enhanced surveillance following restocking to confirm freedom from infection.

Funding responses

Certainty of funding will be critical to success in managing a response should an SE outbreak occur. This could be best achieved by including SE in Australia's new cost-sharing arrangements. Adding SE to the list of disease agents is justified on the basis of the potential impact of SE on public health and industry viability should it become endemic.

By including SE in the new cost sharing arrangements, it would provide producers with certainty as to the expected response and ramifications if SE was to be detected in their flock/s and would assist in encouraging producer participation in the surveillance program. It would also provide certainty of funding for the industry and governments involved in a response.

National approach

A national approach for the development and management of an SE Program based on voluntary producer participation is essential. A national management structure is proposed, providing for management of funding and policy issues by a National Management Group. In addition, technical support and development of an AUSVETPLAN disease manual and SOPs should be undertaken by a National SE Technical Committee, in a similar way to that used for managing the risk of Newcastle disease.

Maximising participation

For a national program based on voluntary participation to be effective it is essential to obtain widespread producer adoption of all elements. AEIA should encourage participation by:

- seeking the support of other stakeholders;
- providing an opportunity to market eggs from participating flocks as "SE-Accredited".
- facilitating the transfer of existing participants in the NSW SE Monitoring and Accreditation Scheme to the new Program;
- developing detailed response plans describing the actions to be taken in flocks that are suspected to be infected, providing increased certainty for producers;
- negotiating for inclusion of SE in layer or layer-breeder flocks in the national cost-sharing agreement to provide certainty of funding for any response and compensation for affected producers; and
- developing a national approach to management of surveillance for SE, and contingency planning for response to SE occurrence in the egg industry.

2. In-Shell Pasteurisation of Eggs

Pasteurisation of eggs in the shell was first reported in the mid 1990s (Hou *et al* 1995; Van Lith *et al* 1995) principally for the inactivation of *S.* Enteritidis in the contents of shell eggs. The efficacy of heating eggs in air, water or by microwave was compared by Stadelman *et al* (1996) who reported a 7 log reduction of SE in inoculated eggs without a significant change in function and visual quality of the eggs.

Since that time in the US all jurisdictions that have adopted the FDA Model Food Code are required to serve pasteurised eggs to risk groups i.e. hospital and nursing homes, adults over 55, children and diabetics (US Dept Health and Human Services, 11/00). In an application to FDA seeking approval to market pasteurised eggs by Davidson's Pasteurised Eggs (http://www.fda.gov/ohrms/dockets/dailys/00/apr00/042500/emc0010.doc) for a 5 log reduction, it was estimated the additional cost per dozen to be 38c at retail. To facilitate the adoption of these technologies the FDA released a "Small Entity Compliance Guide for Food Labelling: Safe Handling, Labelling and Refrigeration of Shell Eggs Held for Retail Distribution" in 2001 (FDA, 2001).

A literature search also revealed an application by Sainsbury plc in the UK in 2000 for permission to utilise the technology to reduce risk associated with the consumption of raw or undercooked eggs, particularly by the vulnerable (ACMSF, 2000). Also in 2000 the FDA approved the use of Ionizing radiation (electron beam and gamma) to reduce the level of *Salmonella* in the egg (Mermelstein, 2001).

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