final report

Project code: A.COP.0031

Prepared by: Peter Horchner

Symbio Alliance

Date submitted: September 2006

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Salmonella serotypes in meat meal

A review of available data

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

Abstract

There is a perception that human cases of human salmonellosis could be traced back to meat meal. A review of documented salmonella serotype data across meat meal, chicken and humans in Australia was undertaken to determine whether there is a relationship. The salmonella serotype correlations and/or cause and effect relationship between meat meal, chickens and humans is difficult to assess and may be influenced by many factors. An important factor is other feeds/food eaten by chickens and humans which are not related in any way to the meat meal source. Nonetheless data were analysed and reported. The comparison of salmonella serotype data showed that for the most frequently reported serotypes, the same types were more likely to occur in chickens and humans, but not meat meal and humans.

Executive summary

Salmonella occurs in meat meal from time to time. It is one potential source of contamination of poultry feed and could be a source of contamination of poultry and eggs. Since salmonella is known to be transmitted to people via poultry meat and eggs there is a perception some cases of human salmonellosis could be traced back to meat meal.

An assessment of salmonella serotype data across meat meal, chickens and humans was undertaken to determine whether there was a clear relationship between the three sources.

Data from 2002, 2003 and 2004 was collected and analysed from the National Enteric Pathogens Surveillance Scheme (NEPSS) and OzFoodNet. The data were grouped and analysed using MS Excel to compare the top 10 salmonella serotypes in meat meal, chickens and humans from 2002 to 2004, ranked by frequency of occurrence. The data were also analysed to compare the top 80% of salmonella serotypes in meat meal, chickens and humans from 2002 to 2004, with this percentage relating to the identified number of cases reported during this period.

It was found that that salmonella serotype correlations and/or cause and effect type relationships between meat meal, chickens and humans were difficult to assess and may be influenced by many factors. An important factor is other feeds/food eaten by chickens and humans which are not related in any way to meat meal as a potential source of contamination or infection. Direct correlations were therefore not able to be established. Observations were made on the type of serotypes found in all three sources.

There is no clear relationship between meat meal, chicken and human data as the most common serotypes were different in all the three sources. For meat meal, there were more serotypes represented in the top 80% of cases, than for either chickens or humans. Some common serotypes were present between chicken and meat meal, however these did not follow through to the most commonly reported cases in humans. In other words, the human cases were not linked to common serovars in meat meal.

Furthermore, the comparison of salmonella serotype data showed that of the most reported serotypes, the same types were more likely to occur between chickens and humans, not meat meal and humans.

Contents

1 Background

Salmonella occurs in meat meal from time to time. It is one potential source of contamination of poultry feed and could be a source of contamination of poultry and eggs. Since salmonella is known to be transmitted to people via poultry meat and eggs there is a perception some cases of human salmonellosis could be traced back to meat meal. As a result domestic specifications for meat meal include requirements for meal to be salmonella-free and many countries require that imported meat meal is salmonella-free.

Since the early 1950s it has been recognised that rendered animal by-products both in Australia and overseas are commonly contaminated with Salmonellas (Boland 1979). The use of such contaminated products as ingredients of rations fed to meat producing animals is obviously undesirable. As well as the risk of clinical salmonellosis occurring in animals, with possible mortality or loss of production, there is the potential for infection of humans by the meat from these animals (Williams 1975).

The common assumption is that Salmonella occurring in food animals are those found in animal feeds and that the animal serovars are then passed into the human food chain, causing disease to humans. While this holds for some serovars/strains there are a number of inconsistencies (Murray 1994).

Lee (1974) reported that more than 70% of successfully investigated case of human salmonellosis from 1966 to 1970 were associated with poultry products and pig meat and it was suggested that the Salmonellas found in man have a pathway of infection from animal feedstuffs to the poultry and pig animal reservoirs, and through pig and poultry products to man.

An assessment of salmonella serotype data across meat meal, chickens and humans was undertaken to determine whether there was a relationship between the three sources.

2 Project Objectives

The overall project objectives for PRCOPIC.031 were to:

- assess the extent of the risk of transmission of salmonella in meat meal to poultry, eggs and subsequently humans.
- develop strategies to reduce the incidence of salmonella in meat meal.

This report on serotypes has been presented separately to the main report with the objective of:

- assess reported data on Salmonella serotypes to determine whether historical data indicates transfer of Salmonella serotypes between feed, animals and humans.

3 Methodology - Section

Data from 2002, 2003 and 2004 was collected and analysed from the following sources:

1. Salmonella serotype data for meat meal and chickens was collected from the National Enteric Pathogens Surveillance Scheme (NEPSS).
2. Human data was collected from OzFoodNet.
3. Other animal feed data was collected from a number of sources including NEPSS .

NEPSS data for 2005 was not released at the time of writing this report (due to be released in October 2006) therefore was not included in the analysis. Permission was sought and received from NEPSS to use their data within this report.

Data was grouped and analysed using MS Excel as follows:

1. Comparing the top 10 ranked salmonella serotypes in meat meal, chickens and humans from 2002 to 2004
2. Comparing the top 80% salmonella serotypes in meat meal, chickens and humans from 2002 to 2004. This percentage relates to the identified number of cases reported during this period.

In analysing and reporting the results of this study, the following definitions and explanations should be noted.

- ’Meat meal’ includes meat meal and meat and bone meal
- ’Chicken’ includes raw chicken meat and chicken products
- S. Sofia is excluded from the data as it is generally considered nonpathogenic to poultry and humans
- ’Human cases’ -The top 10 salmonella infections in each State/Territory for each year were summated. The human data does not include all salmonella infections but gives an overall indication of distribution

A correlation between all data was conducted and observations made regarding the cause and effect of the data.

4 Results and Discussion - Section

4.1 Meat meal, Chicken and Humans

The salmonella serotype correlations and/or cause and effect between meat meal, chickens and humans is difficult to assess and may be influenced by many factors. An important factor is other feeds/food eaten by chickens and humans which are not related in any way to the meat meal source. Any direct correlations are therefore difficult to make, however observations on data can be provided, particularly the type of serotypes found in all three sources.

There is significantly more human data than nonhuman data on salmonella isolates. This is due to the reporting system in Australia, whereby salmonella is a human notifiable disease and, in theory, every isolate from human sources will be tested and serotyped. From 2002 to 2004 there were almost 12,000 cases of salmonella isolates tested and reported.

Conversely, in the period 2002 to 2004, NEPSS reported 799 salmonella isolates from meat meal and 1725 from chicken meat and chicken products (928 excluding S. Sofia). All rendering plants are obliged to test at least one sample of meat meal per week and the total number of samples tested may be well over 5000 per year (approximately 15,000 over the three year reporting period).

However, isolates from poultry, meat meal and vegetable meals are not necessarily serotyped, particularly if they are isolated at an in-house laboratory. The source of meat meal data from NEPSS is largely unknown. It is assumed that most of the data is sourced from laboratories which send positive salmonella isolates for referencing (regardless of the fact that they are not human isolates and there is no requirement for them to do so). In addition, some of the data is thought to originate from project work in the poultry and other related industries.

The top 10 ranked salmonella serotypes in meat meal, chickens and humans for 2002–04 and their percentage distribution are shown in Table 1. Five (5) of the top 10 identified meat meal salmonella serotypes were not present in the chicken or human top ten. The top serotype in chicken and humans (*S.*Typhimurium) was not present in the Top 10 meat meal serotypes.

Table 1 Top 10 salmonella serotypes in meat meal, chickens and humans for 2002–04

Meat meal (n = 530)			**Chicken (n = 816)**			**Human (n = 10 779)**	
S. Anatum	18.1%		*S.* Typhimurium	27.5%		*S.* Typhimurium	55.4%
S. Orion	11.1%		*S.* Infantis	26.8%		*S.* Saintpaul	7.8%
S. Infantis	5.9%		*S.* Virchow	9.8%		*S.* Virchow	6.9%
S. Agona	5.4%		*S.* Kiambu	4.6%		*S.* Birkenhead	5.5%
S. Tennessee	5.3%		*S.* Mbandaka	4.6%		*S.* Chester	4.3%
S. Senftenberg	5.1%		*S.* Singapore	4.4%		*S.* Infantis	2.8%
S. Ohio	4.1%		*S.* Agona	3.2%		*S.* Aberdeen	2.7%
S. Cerro	4.0%		*S.* subsp I ser 16:1,v:-	3.0%		*S.* Hvittingfoss	2.6%
S. Singapore	3.8%		*S.* Zanzibar	2.0%		*S.* Mississippi	1.8%
S. Mbandaka	3.5%		*S.* Ohio	1.8%		*S.* Muenchen	1.5%

When comparing serotypes from each source for the Top 10 (meat meal, chicken, human) the following relationships were made (Tables 2, 3). Table 2 shows that 'meat meal/chicken' had the most common serotypes from the Top 10. Of more relevance however, would be the summation of percentages between each source (Table 3). This shows the summed percentage of serotypes grouped between each source in the Top 10. The 'Chicken/human' relationship was the most weighted.

Table 2: Number of same serotypes between each source in the Top 10

Relationship	**Number of same serotypes**	**Serotypes**
Meat meal/chicken	5	*S.* Infantis, *S.* Agona, *S.* Ohio, *S.* Singapore. S. Mbandaka
Chicken/human	3	*S.* Typhimurium, *S.* Infantis, *S.* Virchow
Meat meal/human	1	*S.* Infantis

Table 3: Summed percentage of serotypes in the Top 10

Relationship					**Summed %**	**Ratio**
Meat meal/chicken	Meat meal	22.7%	Chicken	40.9%	**63.6%**	**6**
Chicken/Human	Chicken	64.1%	Human	65.1%	**129.2%**	**13**
Meat meal/Human	Meat meal	5.9%	Human	2.8%	**8.7%**	**1**

Results were also analysed using the top 80% salmonella serotypes and percentage distribution in meat meal, chickens and humans as shown in Table 4. For meat meal, there was a much greater number of serotypes represented in the top 80% than for either chickens or humans.

When comparing serotypes from each source in the Top 80%, similar relationships to the Top 10 were found (Tables 5 - 6). Table 5 shows that 'meat meal/chicken' had the most common serotypes from the Top 80% and there were no 'meat meal/human' relationships. As for the Top

10 however, when summating percentages, the 'Chicken/human' relationship was again most weighted (Table 6).

Table 4 Top 80% salmonella serotypes in meat meal, chicken and human for 2002–04

Meat meal (n = 638)			**Chicken (n = 752)**			**Human (n = 9443)**	
S. Anatum	18.1%		*S.* Typhimurium	27.5%		*S.* Typhimurium	55.4%
S. Orion	11.1%		*S.* Infantis	26.8%		*S.* Saintpaul	7.8%
S. Infantis	5.9%		*S.* Virchow	9.8%		*S.* Virchow	6.9%
S. Agona	5.4%		*S.* Kiambu	4.6%		*S.* Birkenhead	5.5%
S. Tennessee	5.3%		*S.* Mbandaka	4.6%		*S.* Chester	4.3%
S. Senftenberg	5.1%		*S.* Singapore	4.4%			79.8%
S. Ohio	4.1%		*S.* Agona	3.2%			
S. Cerro	4.0%			81.0%			
S. Singapore	3.8%						
S. Mbandaka	3.5%						
S. Zanzibar	3.4%						
S. Livingstone	2.9%						
S. Bovismorbificans	2.8%						
S. Havana	2.4%						
S. Johannesburg	2.1%						
	79.8%						

Table 5: Number of same serotypes between each source in the Top 80%

Relationship	**Number of same serotypes**	**Serotypes**
Meat meal/chicken	4	*S.* Infantis, *S.* Agona, *S.* Singapore. *S.* Mbandaka
Chicken/human	2	*S.* Typhimurium, *S.* Virchow
Meat meal/human	0	–

Table 6: Summed percentage of serotypes in the Top 80%

Relationship					**Summed %**	**Ratio**
Meat meal/chicken	Meat meal	18.5%	Chicken	39.1%	**57.6%**	**6**
Chicken/Human	Chicken	37.3%	Human	62.3%	**99.6%**	**10**
Meat meal/Human	Meat meal	0.0%	Human	0.0%	**8.7%**	**0**

4.2 Other animal feeds

Data sets of 45 or greater were analysed for salmonella serotypes for other animal feeds. NEPSS reports data for many animal feeds but the numbers of isolates from 2002 to 2004 is low for many of these feeds and hence can not be analysed. The animal feeds tested include canola (n = 167), soymeal (45), sunflower meal (24), poultry feed (18), corn meal (3), cottonseed meal (47), stock feed (2), pig feed (1), feather meal (21), unspecified grain (3), blood meal (8) and fish meal (14).

The top 80% of salmonella serotypes for feeds are shown in Table 7. *S.* Agona featured prominently in the canola and soymeal feeds (53.9% and 73.3% respectively). In comparing this data with the meat meal data provided in Table 4, meat meal has a much greater number of serotypes in the Top 80% than other animal feeds (15 serotypes in meat meal compared with 3 for canola, 2 for soymeal and 6 in cottonseed meal).

Table 7 Animal feeds and salmonella serotype distribution (Top 80%)

Animal feed	Salmonella serotype	Percentage (%)
Canola	*S.* Agona	53.9
	S. subsp I ser 4,12:d:-	18.0
	S. Orion	9.0
Soymeal	*S.* Agona	73.3
	S. subsp I ser 4,12:d:-	15.6
Cottonseed meal	*S.* subsp I ser 16:1,v:-	29.8
	S. Cubana	14.9
	S. Tennessee	12.8
	S. Agona	8.5
	S. Orion	8.5
	S. Mbandaka	6.4

5 Success in Achieving Objective

This specific reports objective was to assess reported data on Salmonella serotypes to determine whether historical data indicates transfer of Salmonella serotypes between feed, animals and humans.

The results from NEPPS and other Salmonella serotype that of the most reported serotypes, the same types were more likely to occur between chickens and humans, not meat meal and humans.

6 Impact on Meat and Livestock Industry – now & in five years time

- Now: Based on the outcome of this report, there is little impact on the feed industry immediately
- Future: Serotype data should continue to be monitored in order to determine whether there are changing trends

7 Conclusions and Recommendations

There is no clear relationship between meat meal, chicken and human data for salmonella as the most common serotypes varied between the three sources. For meat meal, there was a much greater number of serotypes represented in the top 80% of cases, than for either chickens or humans. Similar serotypes were present between chicken and meat meal, however these did not follow through to the most reported cases in humans.

8 Bibliography

Boland PH, Salmonella in meat and bone meal (1979) Australian Advances in Veterinary Science, 1979, p 33-34

Lee JA (1974) Recent trends in human salmonellosis in England and Wales: the epidemiology of prevalent serotypes other than *Salmonella typhimurium*, J Hyg Camb 72:329

Murray CJ (1994) Salmonella serovars and phage types in humans and animals in Australia 1987–1992, Aus Vet J, 71(3):78

NEPSS Non-human Annual Report 2002, Issue No. 2/02, October 2003

NEPSS Non-human Annual Report 2003, Issue No. 2/04, October 2004

NEPSS Non-human Annual Report 2004, Issue No. 2/05, November 2005

Reported foodborne illness and gastroenteritis in Australia: Annual report of the OzFoodNet network, 2002, Vol 27 No 2, June 2003

Reported foodborne illness and gastroenteritis in Australia: Annual report of the OzFoodNet network, 2003, Vol 28 No 3, September 2004

Reported foodborne illness and gastroenteritis in Australia: Annual report of the OzFoodNet network, 2004, Vol 29 No 2, June 2005

Williams BM (1975), Environmental considerations in salmonellosis, Vet Rec, 96:318