National Veterinary Institute

The surveillance and control programmes for *Salmonella* in live animals, eggs and meat in Norway

Jorun Jarp
Bjarne Bergsjø
Torkjel Bruheim
Kjell Nyberg
Kjell Ingvar Flesjå
Magne Skjervheim

Annual report

2002

www.vetinst.no

INTRODUCTION

The Norwegian *Salmonella* control programme for live animals, eggs and meat, consists of two separate surveillance programmes, one for live animals (pigs, cattle and poultry), and one for fresh meat (pigs, cattle and sheep) and poultry meat (1). The programmes are approved by the EU Commission (EFTA Surveillance Authority Decision No. 68/95/COL of 19.06.95), and due to the favourable *Salmonella* situation in Norway, Norway can require additional guarantees regarding *Salmonella* when importing live animals and feed and food products of animal origin from the European Union.

The programmes were launched in 1995, simultaneously with the programmes in Sweden and Finland (2, 3), and in connection with the Norwegian negotiations for membership in the European Union.

The recorded incidence of human salmonellosis has increased in Norway during the last three decades. A particularily steep rise in the early 1980s was due to the emergence of *S.* Enteritidis worldwide. Since 1998, the incidence of human salmonellosis has remained almost constant, except for a peak in 2001. In 2002 1,497 cases were reported, this number being about 20% lower than in 2001 (4). About 80% of the patients with salmonellosis have been infected abroad. The number of reported cases of salmonellosis corresponds well with charter tourism to foreign countries. In Norwegian production animals and animal products, the number of positive samples has constantly remained at a very low level during the last decades.

Both the programme for live animals, and the programme for fresh meat and poultry meat are based on bacteriological examination for *Salmonella*. Isolation of any *Salmonella* sp. is notified to the authorities responsible for the programmes. The Animal Health Authority maintains overall responsibility for the *Salmonella* surveillance and control programme for live animals, while the Norwegian Food Control Authority is responsible for the *Salmonella* surveillance and control programme for fresh meat and poultry meat. The National Veterinary Institute coordinates both programmes, examines the faecal samples and publishes the results in monthly and annual reports. The Municipal Food Control Authorities perform the examination of samples collected at slaughterhouses and cold stores.

The occurrence of *Salmonella* in Norwegian production animals is very low compared to most other countries. It is very important to maintain this favourable situation and to reduce the risk this organism poses for human health.

AIMS

The aims of the programmes are to ensure that Norwegian food animals and food products of animal origin are virtually free from *Salmonella*, and to provide reliable documentation of the prevalence of *Salmonella* in the livestock populations and their products. The number of samples examined in the different parts of the programmes is sufficient to detect *Salmonella* if the prevalence in the population is at least 0.1%, with a confidence level of 95%. When *Salmonella* is isolated from live animals, action is taken to eliminate the infection, prevent transmission to other herds, and prevent contamination of food products.

MATERIALS AND METHODS

The *Salmonella* surveillance and control programme for live animals includes faecal samples from swine and poultry, and lymph node samples from cattle and swine. The *Salmonella* surveillance and control programme for fresh meat and poultry meat includes swab samples from cattle, swine and sheep carcasses, neck skin samples from poultry and samples of minced meat from slaughterhouses and cold stores.

Sampling scheme - live animals

Swine

In Norway there are about 175 elite and multiplier breeding herds. More than 95% of breeding animals are purchased from these herds. All elite and multiplier breeding herds are surveyed at herd level. Once a year, pooled faecal samples are collected from each pen (up to a maximum of 20) containing piglets aged two to six months. If there are no piglets at this age, individual faecal samples (up to a maximum of 59) are taken from all sows (5). Surveillance of the rest of the pig population is based on lymph node samples from a representative proportion of all pigs slaughtered in Norway.

Poultry

All breeding flocks and commercial production flocks, except layer flocks with less than 250 birds, are included in the programme. The sampling of certified breeding flocks is performed in accordance with the zoonosis directive (Council Directive 92/117/EEC) (Table 1). All broiler flocks and flocks of turkeys, ducks and geese other than breeders are sampled one to three weeks before slaughter (faecal samples), while layer flocks are sampled twice during the rearing period and once or twice during the egg laying period (1).

Table 1. Sampling of breeders (simplified)

Category of poultry		Time of sampling	Sample material
Grandparents	Day old	Day 1	Organs or meconium
	Rearing	1-2 weeks, 4 weeks, 9-11 weeks and 13-14 weeks	Faecal samples
	Egg production*		
	-from the house	Monthly	Faecal samples
	-in the hatchery	Every 2nd week of production	Organs or meconium
Parents	Day old	Day 1	Organs or meconium
	Rearing	4 weeks and 2 weeks before start of production	Faecal samples
	Egg production* - in the hatchery	Every 2nd week of production	Organs or meconium

* In small hatcheries (< 1,000 eggs) a modified sampling scheme is used, with sampling from the house every two weeks.

Lymph node samples

The surveillance is based on sampling a representative proportion of all cattle and swine slaughtered in Norway. A total of 3,000 lymph node samples from each of the species are to be collected at slaughterhouses. The estimated sample size for each slaughterhouse is based on the proportion of cattle and swine slaughtered at this site in relation to the total number of cattle and swine slaughtered in the country. The sampling is distributed evenly throughout the year and over the week.

An equal number of lymph node samples should be collected from sows and slaughter pigs.

Clinical cases - all species

All animals with clinical symptoms that could be attributed to salmonellosis are tested. In addition, all sanitary slaughtered animals are tested for the presence of *Salmonella*.

Sampling scheme - fresh meat and poultry meat

Swab samples from carcasses

The testing of slaughtered pigs, cattle and sheep for *Salmonella* is done by swabbing carcass surfaces. About 3,000 swab samples are taken at the slaughterhouses from each of the species. The sampling is done before the carcasses are refrigerated, near the end of the slaughter line. The swabbing is performed according to Appendix 5 in the *Salmonella* control programme (1). Approximately 1,400 cm^2 per carcass is swabbed (somewhat less for sheep) for each sample. The percentage ratio of onsite slaughtered animals in relation to the national total is used to calculate the sample size for each slaughterhouse. The sampling is distributed evenly throughout the year and over the days of the week.

Neck skin samples

Pieces of neck skin are used for *Salmonella* testing in broilers, turkeys, ducks and geese. At each slaughterhouse, a minimum of five neck skin samples is collected per day. At least one sample must be taken from each slaughtered flock. The samples are marked and pooled according to Appendix 6 in the programme (1). Approximately 10,000 are taken, which corresponds to a confidence level higher than 95% for the surveillance of the poultry population and a confidence level of 95% at each slaughterhouse.

Food products

The surveillance and control programme in cutting plants and cold stores examines the production hygiene. The samples can be taken from minced meat, from the equipment or from trimmings. Each sample consists of 25 grams of meat. Each production line is sampled separately. The sampling is done randomly during operation.

Pre-packed fresh meat intended for cold stores does not have to be examined if originating from cutting plants which are included in the programme. Fresh packed or repacked meat should be sampled. The number of samples taken in cutting plants and cold stores is given by the production capacity of the plant, and ranges from one sample per day to two per year.

Laboratory methods

Lymph nodes and swab samples are pooled in groups of five before testing. Each neck-skin sample is divided into two equal parts. One part is pooled with other samples and the other half is stored separately at 4°C until the results of the bacteriological examination are ready. Each pooled sample of neck skin contains four to twelve individual samples. All other samples are examined separately.

Microbiological investigation of the samples is carried out according to the Nordic Committee on Food Analysis Method No. 71, slightly amended to make the method applicable to the various kinds of materials. This is a qualitative bacteriological method based on selective enrichment and cultivation. All positive samples are confirmed and serotyped by a reference laboratory.

RESULTS

Live animals

Swine

A total of 2,297 faecal samples from 169 elite and multiplier breeding herds (including AI centres and test stations) were examined in 2002 (Table 2). *Salmonella* was not detected in any of the samples.

Table 2. Sampling in elite and multiplier breeding herds in the *Salmonella* surveillance and control programme in 2002

	No. of pooled samples	No. of individual samples	No. of herds tested	Total no. of herds*
Elite breeding herds	839	7	63	68
Multiplying herds	1,274	76	103	100
AI and testing stations	42	59	3	5
Total	2,155	142	169	173

* Total number of herds is based on data from the Norwegian Pig Health Service, January 2003.

Poultry

A total of 6,977 samples from 1,638 different holdings were examined (Table 3). *Salmonella* was not detected in any of the samples.

Table 3. Sampling of poultry holdings in the *Salmonella* surveillance and control programme in 2002

Poultry breeding flocks		No. of samples tested	No. of holdings tested	No. of holdings in Norway*
Grandparents				
Layers		29	5	5
Broiler production		15	1	1
Parents				
Layers		175	5	7
Meat production	- Broilers	1,070	81	82
	- Turkeys	156	4	4
	- Ducks	19	3	4
	- Geese	3	2	2
Total – Breeders		1,467	103	103
Other commercial poultry				
Pullets		338	29	42**
Layers		1,647	944	1,139**
Meat production	- Broilers	3,651	650	n.a.
	- Turkeys	383	77	n.a.
	- Ducks	38	6	n.a.
	- Geese	6	3	n.a.
Total - Non breeder holdings		6,063	1,709	n.a.
Total		**7,530**	**1,812**	n.a.

* Total numbers of certified herds are based on data from the Animal Health Authority. Total numbers of breeding flocks are based on data from the Register of Production Subsidies (31 July 2002).

** Including herds with more than 250 animals.

n.a.= Not available.

Lymph node samples from cattle and swine

In 2002, a total of 2,370 lymph node samples from cattle were examined (Table 4). *S.* Javiana was detected in one lymph node sample (Table 4). This gives an estimated prevalence of *Salmonella* of 0.04% at the individual animal level.

A total of 2,606 lymph node samples from swine were examined (Table 4), about 28% from sows and 72% from slaughter pigs. *S.* Typhimurium was detected in four samples.

Table 4. Individual lymph node samples from cattle and swine in the *Salmonella* surveillance and control programme in 2002

	No. of positive samples	No. of samples
Cattle	1	2,370
Slaughter pigs	3	1,889
Sows	1	717

Swab samples from cattle, sheep and swine carcasses

A total of 7,564 swab samples from 46 slaughterhouses were examined in 2002 (Table 5). *Salmonella* was not detected in any of the samples investigated.

Table 5. Number of swab samples from carcasses examined in the surveillance and control programme for *Salmonella* in 2002

	Swine	Sheep	Cattle	Total
No. of positive samples	0	0	0	0
No. of samples examined	2,615	2,522	2,419	7,556
No. of slaughterhouses involved/no. of slaughterhouses that slaughter each of the species	29/31 *	32/38 *	40/43 *	46/48 *

* Slaughterhouses where the number of slaughtered animals of a species is less than 100 according to the Slaughter Statistics for 2002, are not included.

Neck skin samples from poultry

A total of 6,959 neck skin samples from poultry were examined in 2002 (Figure 1C). *Salmonella* was not detected in any of the samples. The samples came from all the 10 poultry slaughterhouses in Norway. Nearly 80% of the samples came from broilers, 12% from layers and 8% from other species (turkey, duck and goose).

Cutting plants and cold-stores for fresh meat and poultry meat

A total of 2,371 samples of minced meat from 110 different plants were examined. *Salmonella diarizonae* was detected in one of the samples (Table 6) which gives an observed prevalence of 0.04%.

Follow-up in herds with samples positive for Salmonella

In the cattle herd where *S.* Javiana was detected from one lymph node sample, individual samples from all cows and pooled samples from the calves were taken three consecutive times. *S.* Javiana was detected in six out of 97 samples taken in December 2002. Bacteriological analyses performed on faeces samples taken from 90 and 82 animals in January and February in 2003 were all negative. The restrictions imposed upon the herd were lifted in March 2003.

Surveillance overview

As shown in Figure 1 the number of samples examined in 2002 was about the same as the number in 2001, but the target of 3,000 of each sample category and species was not reached.

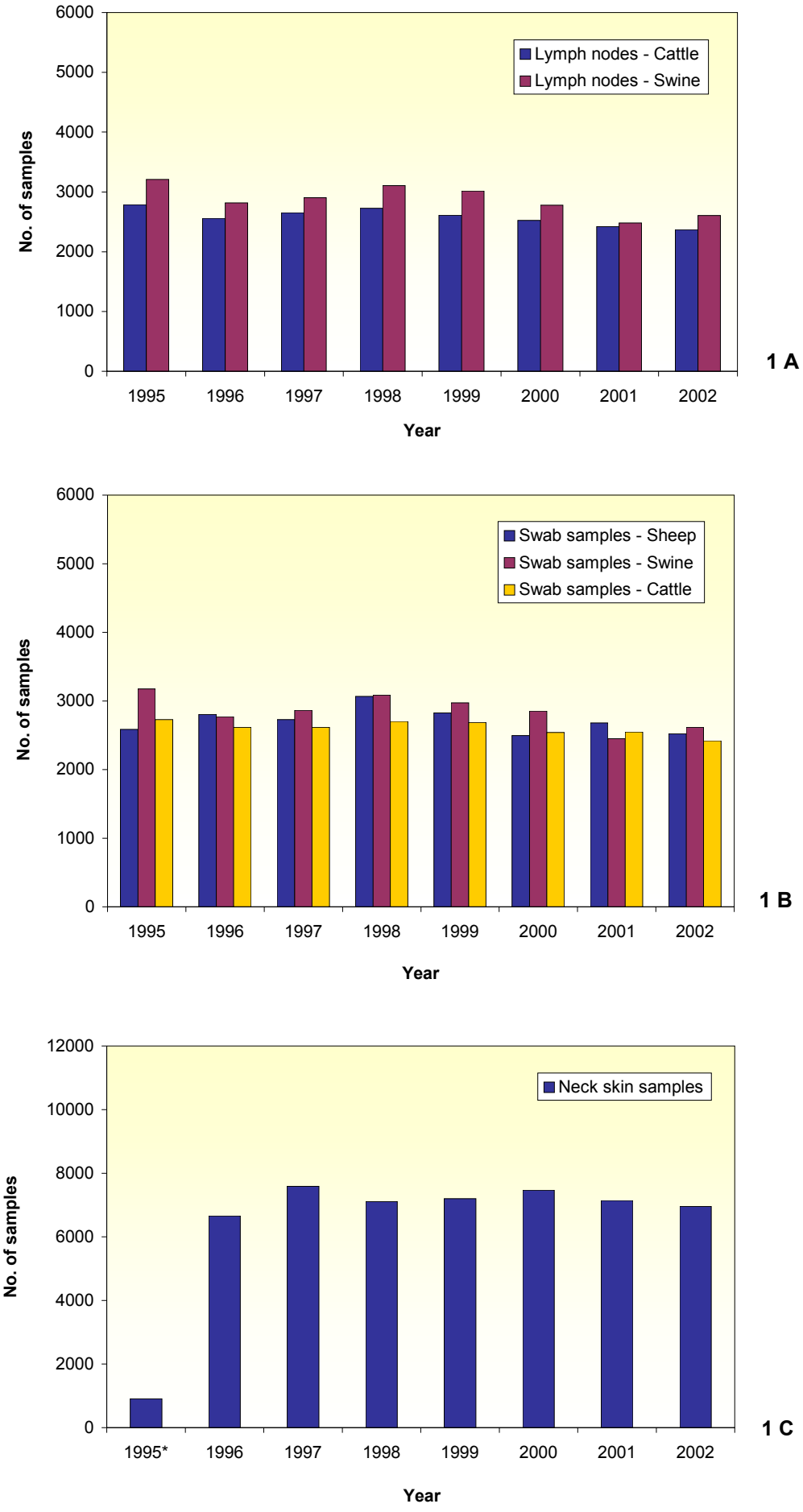

Figure 1. The number of lymph node samples (A), swab samples (B) and neck skin samples (C) in the surveillance and control programme during the time period 1995-2002.

Tables 6 and 7 give an annual overview of positive samples and serotypes found since the programmes started in 1995.

Table 6. Samples positive for *Salmonella* in the *Salmonella* surveillance and control programme for live animals, by species and sample material during the time period 1995-2002

	Cattle	Swine		Poultry		
Year	Lymph nodes	Breeders	Lymph nodes	Breeders	Other	**Serotypes**
1995	3	1	4	-*	-*	*S.* Typhimurium, *S.* Dublin, *S. diarizonae*
1996	3	0	0	0	5*	*S.* Typhimurium, *S.* Livingstone, *S.* Newport, *S.* Bredeney, *S.* Schwarzengrund, *S.* Konstanz
1997	2	0	0	0	0	*S.* Typhimurium
1998	1	0	0	0	2	*S.* Livingstone, *S. diarizonae*
1999	1	0	4	0	2	*S.* Typhimurium, *S.* Livingstone, *S.* Infantis, *S.* München, *S.* Saintpaul
2000	2	1	2	0	2	*S.* Typhimurium, *S.* Hadar, *S.* Hadar/Bareilly, *S.* Poona, *S.* Aberdeen
2001	1	0	0	1	0	*S.* Typhimurium, *S.* Agona
2002	1	0	4	0	0	*S.* Typhimurium, *S.* Javiana

* For poultry, the programme was not completed until 1996. Consequently, data for 1995 are not available. Three of the cases in broilers in 1996 were caused by spread of infection from breeder herds where *Salmonella* was detected in 1995.

Table 7. Summary of samples positive for *Salmonella* in the surveillance and control programme for fresh meat and poultry meat during the time period 1995-2002

Year	Cattle	Sheep	Swine	Poultry	Minced meat	Serotype
1995	0	0	0	12	1*	*S.* Livingstone (x 12), *S.* Typhimurium
1996	0	3	0	0	0	*S. diarizonae*/61: k:1,5
1997	0	0	0	0	1	*S.* Dublin
1998	0	2	0	0	0	*S. diarizonae*/61: - :1,5
1999	0	1	0	0	0	*S. diarizonae*/61: k:1,5
2000	0	0	0	0	1	*S. diarizonae*/61: k:1,5
2001	0	1	0	0	1	*S. diarizonae*/61: - :1,5 *S. diarizonae*/61: k:1,5,7
2002	0	0	0	0	1	*S. diarizonae* 61: k:1,5,7

* In 1995 meat samples were examined instead of minced meat.

DISCUSSION

The results from the *Salmonella* surveillance programme in 2002 are in accordance with previous findings (6) that the Norwegian cattle, swine, sheep and poultry populations are only sporadically infected with *Salmonella*. The prevalence is well below 0.1% in any of the examined populations for any of the years the surveillance programme for live animals has run. The number of positive samples has never exceeded 10 in total per year. *S.* Typhimurium has been isolated frequently, but *S.* Enteritidis has never been found in the surveillance programme.

The fact that only about 20% of the recorded human cases of salmonellosis have a domestic origin show that domestic food products of animal origin represent a small risk with regard to *Salmonella* in humans. In 2002 it was shown that two clones of *Salmonella* in the wild fauna (wild birds and hedgehogs) represented a risk of infection in humans and especially for children below four years of age. Such wild reservoirs might also be considered a risk for infection in farm animals. As no increase in prevalence in the animal populations has been demonstrated, it could be assumed that the farm animals are well protected from these reservoirs.

In parts of the surveillance programme pooled samples from individual animals are examined. Several times it has been difficult to trace the bacteriological findings back to the individual samples, and thereby it may be difficult to find out if more than one animal is infected in affected farms during follow-up. *S.* Javiana was found in one lymph node sample from one individual cattle investigated in the surveillance programme in 2002, and in the follow-up samples of faeces taken from all the cattle in the herd the same bacteria was isolated from several animals. Then, in two subsequent samplings all examined samples were negative.

The animal production in Norway has for the past years undergone several structural changes as the number of farms has decreased while the size of the farms has slightly increased. But the Norwegian animal herds are relatively small compared to the international standard. The number of swab and lymph node samples examined per species should have been 3,000 per year, but such numbers have only been reached in some of the years and since 1998 a clear negative trend in sample size has appeared.

The production of poultry meat produced in Norway has increased over the past years and nearly reached 46,000 tons in 2002. The percentage distribution between the various species was 82% broiler meat, 6% hen and 11% turkey. The number of neck skin samples examined should, according to the sampling criteria, not decrease because the sample size per slaughterhouse is based on the number of poultry flocks slaughtered. The relative proportion of turkey samples is somewhat smaller than what would be expected based on the production volume.

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