



**UK WIDE SURVEY OF *SALMONELLA* IN RAW
SHELL EGGS USED IN CATERING PREMISES**

FINAL REPORT

FSA PROJECT CODE - B18017

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Glossary

ACMSF	Advisory Committee on the Microbiological Safety of Food
BBD	Best before date
BGA	Brilliant green agar
BPW	Buffered peptone water
Defra	Department for Environment Food and Rural Affairs
DH	Department of Health
EC	European Commission
EEDD	Environmental and Enteric Diseases Department
EFSA	European Food Safety Authority
EHD	Environmental Health Department
EHO	Environmental Health Officer
EMI	Egg Marketing Inspectorate
EQA	External Quality Assurance
EU	European Union
FEPTU	Food and Environmental Proficiency Testing Unit
FSA	Food Standards Agency
HACCP	Hazard Analysis and Critical Control Points
HPA	Health Protection Agency
LACORS	Local Authority Co-ordinators of Regulatory Affairs
LAs	Local Authorities
LEP	Laboratory of Enteric Pathogens
LIMS	Laboratory information management systems
MKTTn	Muller-Kauffmann Tetrathionate Novobiocin broth
MRA	Microbiological Risk Assessment
NPHS-W	National Public Health Service for Wales
PT	Phage Type
QA/QC	Quality assurance / Quality control
RVS	Rappaport-Vassiliadis soya peptone broth
SOP	Standard Operating Procedure
TSO	Trading Standards Officer
UKAS	United Kingdom Accreditation Service
XLD	Xylose lysine desoxycholate agar

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The Agency would also like to thank the Egg Marketing Inspectorate at Defra for providing information and advice during the survey and the caterers which agreed to take part in the survey, for their cooperation in the collection of samples.

Executive Summary

The Food Standards Agency's (FSA's) survey of *Salmonella* contamination of raw shell eggs used in catering premises was carried out over a period of 14 months between November 2005 and January 2007. The main objectives of the survey were to estimate the prevalence of *Salmonella* in raw shell eggs used by caterers and to identify the *Salmonella* serotypes and phage types and their antimicrobial susceptibility. The study also looked at whether there were any associations between types of *Salmonella* and the country of origin of eggs. Information on egg storage and handling practices in catering premises was also gathered.

A total of 1,588 pooled samples of six eggs were collected at random from 1,567 catering premises in England, Wales, Scotland and Northern Ireland. The shells and contents of eggs were tested separately for the presence of *Salmonella*. The overall finding was that 6 pooled samples were found to be contaminated with *Salmonella* spp. on the shell of the egg giving a prevalence of 0.38%. Of these *Salmonella* Enteritidis was detected in 5 samples with a prevalence of 0.31%, with *S. Enteritidis* PT4 at 0.19%.

Of the 6 *Salmonella* shell positive samples, 1 was also contents positive making a total of 7 distinct isolates recovered from the survey. From these two different serotypes were recovered of which the most common was *S. Enteritidis* (5/6). There were three different phage types (PT) of *S. Enteritidis* with PT4 predominating (3/5). *S. Mbandaka* was also isolated. None of the *Salmonella* isolates exhibited antimicrobial resistance.

Eggs sampled were produced in eight European countries (France, Germany, Poland, Portugal, Republic of Ireland, Spain, The Netherlands, and the United Kingdom), with most (89%) originating from the UK. *Salmonella* spp. were detected from five egg samples that were produced in the UK and from one

produced in Germany. The six *Salmonella* contaminated eggs were linked with six different producers.

The survey's kitchen practice element showed evidence of poor egg storage and handling practices in catering premises. Over half (55%) did not store their eggs under refrigerated conditions, a fifth (20.7%) of egg samples had expired best before dates or were in use after three weeks of lay indicating poor stock rotation, and 37.1% mixed and pooled eggs for use during the day.

Eggs are a commonly consumed food that may occasionally be contaminated with *Salmonella* at different rates according to their place of origin. Caterers need to be aware of this continuing hazard, adopt appropriate control measures and follow advice provided by the FSA in order to reduce the risk of infection.

1. Introduction

The Food Standards Agency (FSA) has made a commitment to further reduce food poisoning by 2010. Food poisoning is often debilitating and occasionally fatal. It also imposes a significant economic burden on a nation in medical costs and lost working time (Adak *et al.* 2002, FSA 2000, Mead *et al.* 1999).

Infection with *Salmonella* Enteritidis remains an important public health problem in Europe and some parts of the world (Fisher 2004, Drociuk *et al.* 2003, Mishu *et al.* 1994). Outbreaks caused by *Salmonella* have been associated with a variety of foods. However, outbreaks caused by *Salmonella* Enteritidis are closely associated with eggs and egg products (Doorduyn *et al.* 2006, Drociuk *et al.* 2003, Gillespie *et al.* 2005, Hayes *et al.* 1999, Mishu *et al.* 1994, Mølbak and Neimann 2002, Schmid *et al.* 1996). Concerns are such that the European Commission (EC) Scientific Committee on Veterinary Measures relating to Public Health has identified eggs and egg products containing raw eggs as a food group which pose a hazard to public health (EC 2003a).

Raw shell eggs may become contaminated with *Salmonella* spp. in several ways. The outside of the egg may be contaminated by faeces after laying, or be infected with *Salmonella* spp. during laying if the reproductive tract is infected by the organism. *Salmonella* spp. on the outside of the egg can migrate through the porous shell to the interior, particularly when newly-laid or under humid conditions. Contamination of the egg contents can also arise from infection of the reproductive tissue prior to egg development (de Buck *et al.* 2004, Humphrey 1994). Salmonellae can survive in lightly cooked eggs or raw egg dishes to cause human disease (Humphrey *et al.* 1989, 1990). The UK Chief Medical Officer (DH 1988a, 1988b) and Food Standards Agency (FSA 2003) have drawn attention to the risk associated with eating raw and lightly cooked eggs and issued public health advice on the safe handling and use of eggs.

In the UK and Western Europe, the predominant phage type (PT) responsible for eggborne *S. Enteritidis* infection has been PT4 (Fisher 2004, Gillespie *et al.* 2005). Following large epidemics of *S. Enteritidis* in the late 1980s, mainly due to PT4, a significant decline in human *S. Enteritidis* PT4 infection in England and Wales has occurred since 1997, largely due to industry control programmes such as the vaccination of layer flocks and quality assurance schemes incorporating improved biosecurity (ACMSF 2001, Cogan and Humphrey 2003). However, since 2002, the emergence of egg-associated *S. Enteritidis* PTs other than PT4 causing human infection has taken place, with the greatest increases occurring in *S. Enteritidis* PT1 and PT14b. Three quarters of these outbreaks occurred in commercial catering premises (HPA 2004, 2005a). Surveillance of salmonellosis from 1998 to 2003 has also identified increases in *S. Enteritidis* non-PT4 in other European countries (Fisher 2004). These resurgences are thought to be associated with major changes in market supply with the import of eggs from other egg producers in Member States where there was a lack of vaccination of layer flocks against *Salmonella* or controlled assurance schemes in place (Fisher 2004, Nygård 2002, van Pelt *et al.* 2004).

Information on the incidence of high-risk egg preparation practices that allow growth or survival of *S. Enteritidis* in eggs in these premises is also needed. For example, mixing of shelled eggs and storing at ambient temperatures could allow one egg to contaminate a large batch of pooled eggs. Other practices that support *S. Enteritidis* growth and/or survival include inadequate cooking of eggs (Humphrey *et al.* 1989, 1990) and contamination of equipment, food handler hands or food with *S. Enteritidis* (Bradford *et al.* 1997, Humphrey *et al.* 1994). The risk of *S. Enteritidis* transmission can be reduced greatly by the use of pasteurised eggs, particularly in lightly cooked dishes (FSA 2003).

Throughout Europe (including the UK), *Salmonella* is controlled in the egg production chain under Regulation (EC) No 1168/2006, which sets targets to reduce *Salmonella* prevalence in poultry and eggs in all member states (EC

2006). It is also planned under this Regulation that from January 2010, eggs from *Salmonella* infected flocks will be treated in a manner that guarantees the elimination of *Salmonella*, e.g. the heat treatment of contaminated eggs. Contaminated eggs will therefore be required to be sent for processing into egg products. Traceability of all table eggs (Class A) sold in the EU became mandatory in January 2004, in that shells must be stamped with a distinguishing code (EC 2001). During outbreak investigations this code enables full product traceability by identifying the type of farming system, the country of origin and the precise production establishment (EC 2001).

Surveys and investigations of eggs for *Salmonella* contamination have played an important role in understanding the extent and pattern of contamination (FSA 2004a). Studies of eggs appear to indicate that those originating from some countries outside the UK have a higher rate of *Salmonella* contamination compared to UK-produced eggs. In 2005/6, a survey of non-UK eggs at retail sale found an estimated prevalence of *Salmonella* in 3.3% of samples; of these *S. Enteritidis* had a prevalence estimate of 2.6% (Little *et al.* 2006). The Health Protection Agency (HPA) outbreak-associated examination of eggs during 2002 to 2004 also showed a higher rate of *Salmonella* contamination in non-UK eggs used in catering premises. Most *Salmonella* isolates were *S. Enteritidis* non-PT4 (5.5% in Spanish eggs; 6.3% in eggs of country of origin not known) (HPA 2004, Little *et al.* 2007). In contrast, rates of *Salmonella* contamination in UK-produced eggs appear to have decreased significantly, clearly demonstrating an improved situation (1995/6; 1.0%, 2003; 0.3%) (ACMSF 2001, Elson *et al.* 2005, FSA 2004a).

The Agency has commissioned series of raw shell egg surveys, including this one of eggs at the catering level, and previously one of non-UK eggs at the retail level (FSA 2005a, 2005b, 2004b). The results from these surveys will contribute to providing an indication of where particular contamination problems are occurring and hence where interventions to reduce *Salmonella* contamination

might best be focused. Reported here are the results of a survey to provide an estimate of *Salmonella* contamination of eggs used in catering premises across the UK.

This survey had four principal aims:

- Estimate the prevalence of *Salmonella* in raw shell eggs used in catering premises across the UK;
- Identify the *Salmonella* sero- and phage-types present on and in raw shell eggs used in catering premises and determine the susceptibility of the isolates to antimicrobial drugs;
- Establish any association between country of origin of eggs and presence of particular sero / phage types of *Salmonella*.
- Provide information on egg storage and handling practices in catering premises.

2. METHODS

2.1 Survey design

The main objective of the survey was to determine the level of *Salmonella* contamination of raw shell eggs used in catering premises within the UK. The number of eggs required to be tested to achieve this objective depended on the estimated previous level of contamination and allowing for any change that may have taken place. Since the degree to which the actual rate has changed was unknown, an assumption was made that the estimated prevalence in the survey would be around 1.0%. A 95% confidence interval on this estimate provided a range from a fraction over 0.75% to a fraction above 1.25%; i.e. there is a high confidence that the true prevalence lies within the range (0.75% to 1.25%) (Annex C). Based on this assumption, testing 1,600 samples of six eggs in the course of a year (1 November 2005 – 31 October 2006) would be needed to achieve the required precision. The results were then assessed every month during the survey to ensure that enough eggs were being sampled to achieve the best estimated prevalence possible.

The original sample plan is shown in Annex C with the UK core sample of 1,600 samples of eggs distributed amongst the nations as follows:

- England - 1389 samples (86.8%)
- Scotland - 103 samples (6.4%)
- Wales - 75 samples (4.7%)
- Northern Ireland - 34 samples (2.1%)

Seasonal effects were not investigated. Any catering premises could be included in the survey provided they obtained their eggs from wholesale suppliers and not retail outlets. Catering premises were selected in a manner designed to minimise bias towards particular premises types (see Annex C for premises categories). The proportion of premises of each category within the list of those sampled was intended to reflect the proportion within the local authority's area. Within each

premises category in the local authority's database of food businesses, individual premises was selected without bias by either using a random number generator or selecting every 10th entry. All premises to be sampled were selected at the start of the survey to facilitate the planning of sampling trips. The project lead contractor, the Environmental and Enteric Diseases Department (EEDD), HPA Centre for Infections administered the project together with the Laboratory Survey Co-ordinators co-ordinated sampling in England, Wales, Scotland and Northern Ireland.

Sample numbers up to and including October 2006 were below target (shortfall of approximately 300 samples). The decrease in sampling activity over the summer months was partly due to the impact of outbreak investigations by local authorities and laboratories across three regions as part of the national *Salmonella* Montevideo outbreak investigation over the summer of 2006. Other difficulties identified by participating local authorities included identifying catering premises wholly supplied by wholesalers. Sampling guidance to local authorities was amended in November 2006 to allow catering premises to be revisited for the purpose of sampling eggs as enough time had lapsed to ensure that different batches of eggs to those previously sampled would be in use. Also, premises sourcing eggs from any supplier could be visited as additional data on kitchen practices could be obtained. Sampling within the survey was therefore extended by two months (1 November 2005 – 2 January 2007) to aim to achieve the target number of 1,600 eggs.

Caterers received payment for the eggs at the time of sampling. After collection of the samples, caterers or a representative of the owner of the premises were given the Agency's food survey sampling letter to inform them that samples had been taken from their premises in order to carry out the survey (Annex C). At the end of the survey, larger catering chains were sent a letter by the Agency to the relevant contact at the head office with a list of their premises from which samples had been obtained. The Agency provided caterers and brand owners

with survey results obtained from their catering premises prior to publication of the report.

2.2 Sampling

2.2.1 Sample collection and transportation

Samples were collected by experienced staff from 238 Environmental Health Departments (EHDs) in England, Wales, Northern Ireland, and Scotland (Annex B) between 1 November 2005 and 2 January 2007 using a standardised sampling protocol, sampling form, and sampling plan (Annexes C and D). The Laboratory Survey Co-ordinator at each testing laboratory organised the sampling to cover EHDs, months in which sampling visits were to be made, and number of samples of eggs to be collected each month. The approach was to ensure that the numbers of eggs to be tested were similar for each month.

The country of origin of eggs was identified by the stamp marking on the egg shell, e.g. 1AT12345. The distinguishing number includes an indication of method of production (e.g. 1, free range), origin (e.g. AT, Austria), and the farm where the eggs were produced (e.g. 12345, farm ID) (Annex E). Where the farm has multiple hen houses the farm ID numbers can be appended with a letter (e.g. A, B, C and so on). Annex F provides information on egg production systems, i.e. cage, barn, free range and organic. As it is now a legal requirement for table eggs to be stamp marked, where eggs were found without this marking, these were informally reported to the Egg Marketing Inspectorate (EMI) for further investigation or action.

All raw shell table eggs used in catering premises must be Class A quality and therefore fit for human consumption. The definition of Class A eggs is provided in Annex E. Where eggs sampled were found to be in breach of the Class A marketing standards, these findings were reported to the Agency on an informal basis who in turn contacted the EMI for investigation. At the same time, these

findings were also informally reported to Local Authority Trading Standards Officers (TSOs) by the participating local authorities for further investigation or action.

Samples comprising six eggs were collected at random from the boxes or trays of eggs using gloved hands, and placed in to a clean plastic egg box (BKS Ovotherm UK, premium plastic pack (RPET)). Each box was placed in a separate sterile sampling bag to avoid the risk of cross-contamination during transport and storage. There was no requirement to select specific sizes of eggs, as there was no available scientific evidence of any association between egg size and the prevalence of *Salmonella*. Samples consisted of intact hen eggs with no evidence of gross damage. Samplers sampled eggs without discrimination of country of origin to reflect what was used in the catering industry as a whole during the duration of the survey. Information on whether the eggs were stored in a temperature control environment was also recorded.

During collection of the egg samples, cross-contamination was minimised by taking precautions at all stages to ensure that the equipment used during sampling, transport and storage was not contaminated with *Salmonella*. Samples were kept dry and out of direct sunlight, transported at approximately 20°C and delivered to the testing laboratories within 24 hours of sampling. Samples were collected and transported to the laboratory in accordance with the Food Law Code of Practice and Practice Guidance (FSA 2006), advice provided in LACORS guidance on microbiological food sampling (LACORS 2006), and the FSA Sampling Protocol (Annex C). Samples of raw shell eggs were transported to 28 Official Food Control Laboratories in England, Wales, Scotland and Northern Ireland (Annex D).

2.2.2 Sample information

All relevant information available for the sample was recorded on a sampling form (Annex D). The information included details of the caterer including type

and cuisine, sampler details, date and time of sampling, storage temperature of eggs, size of eggs, pooling of shelled eggs, packing station number, country of origin, production types, pack size, sell by date, best before date, vaccination scheme, and brand name. Other information included, the visual condition of the eggs, the stamp marking on the egg shell, a reference sampling number, a laboratory reference number for each sample and the date and time the sample was received in the laboratory. The form also included a section for the testing laboratory to enter the *Salmonella* test results. The laboratories entered data in to Laboratory Information Systems (LIMS), converted the data onto an Excel[®] spreadsheet and forwarded on a monthly basis to the HPA EEDD, Centre for Infections, for central data collation and analysis.

The laboratory reference sample number acted as a unique identification code in order to clearly link it to a particular sample. The reference number was retained throughout testing and also when *Salmonella* isolates were sent for typing to the HPA Laboratory of Enteric Pathogens (LEP), Centre for Infections.

2.2.3 Sample receipt

Egg samples reached the laboratory within 24 hours of sampling. On receipt at the laboratory, the samples were taken to a dedicated specimen reception and the temperature data logger information was recorded. The temperature of the eggs was held at approximately 20°C and the laboratory testing procedure began within 24 hours of arrival at the laboratory.

Most eggs at the time of both collection and examination were within their best before dates. Eggs with expired best before dates at the time of collection were also examined, to reflect the quality of eggs used by the caterer, these represented a small proportion of the overall sample number.

Laboratories completed their section of the sample form, which included the date sample was received at the laboratory, stamp marking on the egg shell, and

appearance of the eggs, i.e. whether they were clean, dirty, contaminated with faeces or visibly cracked (MAFF 1996b) (Annex E).

Digital photographs of high resolution were also taken of the stamp mark on the eggshell. Photographs were stored under the appropriate laboratory name and reference sample number for samples. This ensured that the stamp mark details could be checked at a later date. All photographs of the egg samples were stored on CD-ROM and sent to the Agency on a monthly basis for further validation and cross checking by the Agency's staff.

2.2.4 Sample examination and isolation of *Salmonella* spp.

Laboratory staff ensured that there was no cross-contamination between boxes and from the surrounding environment. Disposable gloves were worn and changed between each sample of six eggs. Thorough cleaning and disinfection of equipment and work surfaces was undertaken regularly. Environmental monitoring of the laboratory for *Salmonella* contamination prior to egg testing was also carried out regularly throughout the survey.

In addition, raw meat or poultry samples or QA/QC samples containing strains of *Salmonella* spp. were not examined at the same time or before any raw shell eggs were tested. The eggs were cracked in a designated area of the laboratory away from routine food testing. Guidance on 'avoiding cross contamination risks in the food laboratory' was provided in a HPA guidance note (HPA 2005b). The laboratory control strain used was *Salmonella* Nottingham, a serotype rarely associated with foods, including eggs.

Samples of six eggs were aseptically cracked against the rim of a sterile screw topped container; the shells and egg contents were divided and pooled in separate containers. The presence of *Salmonella* was tested in accordance with BS EN ISO 6579: 2002 (BSI 2002). An equal volume of buffered peptone water (BPW) was added to both contents and shell samples and the solutions mixed

and then incubated at 37°C for 18 ± 2 hours. The incubated BPW broths were then sub-cultured into selective enrichment broths; 0.1 ml to 10 ml of Rappaport-Vassiliadis Soya Peptone Broth (RVS) and 1 ml to 10 ml of Muller-Kauffmann Tetrathionate Novobiocin broth (MKTTn) and incubated at 41.5°C and 37°C, respectively for 24 ± 3 hours. After incubation, the broths were sub-cultured on to Xylose Lysine Desoxycholate agar (XLD) and modified Brilliant Green Agar (BGA) plates. Inoculated selective agars were incubated at 37°C for 24 ± 3 hours and then examined for typical and atypical or suspect colonies of *Salmonella*. Serological and biochemical confirmation were carried out on typical or suspect colonies of *Salmonella* from each agar plate. Isolates of *Salmonella* spp. were referred to HPA, LEP for confirmation, serotyping and phage typing for *S. Enteritidis* (Ward *et al.* 1987), antimicrobial susceptibility testing (Frost 1994, Annex G), and archiving. Further methodological detail can be found in the HPA standard operating procedure for the detection of *Salmonella* species (HPA 2005c).

The method used was similar to that of previous surveys of *Salmonella* contamination of eggs in which shells and contents were tested separately (FSA 2004a). It should be noted that there is no method of sample preparation currently in existence that reliably allows the separation of egg shell and egg contents and thus distinguishes shell from content contamination. However, as part of a pan-London study during a public health investigation on eggs, the method has been shown to be robust when using aseptic techniques. This has been proved where shells tested positive in some samples and where contents were negative. Also in the study contents have been found positive with shells testing negative (HPA, personal communication). The results will therefore be reported as a rate per group of six eggs as in previous surveys.

2.2.5 External Quality Assurance (EQA) samples

All 28 participating laboratories are Official Food Control Laboratories and as such are accredited by the United Kingdom Accreditation Service (UKAS) to

undertake microbiological tests of food for *Salmonella* (http://www.food.gov.uk/enforcement/public_analysts/foodcontrollabs). All laboratories thus participate in the HPA Food External Quality Assessment (Proficiency Testing) Extended schemes (EQA). Full details on the scope of EQA schemes are available from the HPA website (HPA 2006).

In both the standard and extended schemes a minimum of 12 simulated food samples are dispatched per year at two-monthly intervals with two samples per distribution, i.e. two samples are dispatched every two months. The extended scheme offers a regular series of freeze dried simulated food samples of known but undisclosed content for proficiency testing to challenge everyday laboratory procedures. The required tests in the standard scheme include *Salmonella* spp. The survey protocol required the testing of EQA samples by a different technician on three occasions throughout the survey, details of which were provided to the Agency at the end of the survey. The laboratories also run internal quality control and assurance programmes in which all laboratory staff undertaking microbiological examination participate. These samples include spiked samples with *Salmonella* spp. in various food matrices. Guidance on the 'recommended minimum internal quality control in food microbiology testing laboratories' is provided in a HPA guidance note (HPA 2005d).

2.2.6 Zoonoses Order 1989

Under the Zoonoses Order 1989, laboratories which isolate *Salmonella* spp. from foodstuffs, must provide Defra with details of the subtype found together with the name of the caterer where the eggs were obtained (Anon 1989). Details of *Salmonella* spp. isolated from raw shell eggs were notified to Defra by HPA EEDD.

2.2.7 Data handling and reporting

In order to ensure a high level of accuracy in data entry, laboratory staff trained and experienced with the Laboratory Information Management Systems (LIMS)

inputted data. All data were then transferred and/or entered into an Excel® spreadsheet and validated by HPA EEDD.

At monthly intervals HPA EEDD submitted a spreadsheet containing details of the samples collected to date, together with a summary and/or bimonthly report on the survey to the Agency. Data on serotyping and phage typing and antimicrobial susceptibility of *Salmonella* isolates were received from the HPA LEP and the results incorporated into the spreadsheet by HPA EEDD. Data provided to the Agency were then cross-checked by Agency staff against the photographs to ensure that they were accurate. Further random spot checks of sample datasets were also performed by the Agency. Each dataset was cross-checked and corrected for accuracy after discussion with the HPA.

2.2.8 Statistical analysis

Data analysis was carried out by Agency statisticians using Microsoft Excel® and by the HPA using Microsoft Excel® and Epi Info version 6.04d. Proportions were compared by the HPA using the Chi squared test (χ^2) and Fisher's exact test. A probability value of less than 5% was deemed to be significant.

3.0 RESULTS

3.1 Approach to statistical analysis

There was no market share data on the origin of eggs used in catering and the type of caterers in the UK and therefore there was no basis on which to construct a sampling frame. However, the Agency used the registered catering premises lists held by the Local Environmental Health Departments upon which to derive an approach to sampling. Lists were generated by selecting premises at random (via random number generator and/or every 10th premises) and if suitable were sampled from.

Although the sampling carried out broadly reflected the type of eggs used in catering premises it could not be considered as representative of UK catering establishments as only a small proportion of the total UK catering sector was sampled. Additionally, in the North West region of England sampling was not possible in some local authorities which may have produced a gap in the supply chain provided by large egg importers known to be located in the region.

The survey saw a large number of UK eggs sampled with less than 10% of the total being of non-UK origin. This approximately reflects the UK egg market where the majority of the UK's egg consumption is in line with UK egg production and imported eggs are only required when supply falls.

3.2 Collection and examination of non-UK egg samples in the survey.

A total of 1,609 groups of 6 eggs were sampled of which 21 were deemed unacceptable for testing and were therefore excluded from the main analysis. Samples were rejected if they were not examined within 24 hours once received by the testing laboratory; if eggs cracked and had leaking contents (n=1); were

duplicate samples (n=1) or if they were sampled from retail premises (n=13). Figures and proportions from this point forward are based on 1,588 groups of 6 eggs.

3.3 Prevalence of *Salmonella* in eggs used in catering premises.

Of the 1,588 samples of six eggs taken, 6 were positive for *Salmonella*. The prevalence for all *Salmonella* spp. was 0.38% (CI: 0.14-0.82%) (Table 1). The most prevalent type was *Salmonella* Enteritidis (0.31%; n= 5) of which phage type 4 was the most common (0.19%; n=3).

Table 1. Prevalence of *Salmonella* in eggs used in catering premises.

	Total No. of positive samples	Prevalence rate (%)	95% CI* (%)	
			Lower	Upper
S. Enteritidis	5	0.31	0.10	0.73
(S. Enteritidis PT4)	3	0.19	0.04	0.55
(S. Enteritidis non-PT 4)	2	0.13	0.02	0.45
S. Mbandaka	1	0.06	0.00	0.35
All <i>Salmonella</i> spp.	6	0.38	0.14	0.82

*, 95% confidence intervals

3.4 *Salmonella* isolates from both shells and content – serotypes, phage types and antimicrobial susceptibility.

At present there are no satisfactory sampling techniques that could effectively allow differentiation between *Salmonella* contamination on the shell and that in contents; therefore the method has the potential to provide false positive or negative results. The method used would give an indication as to the relative proportion of contamination on the shell or in the contents in all *Salmonella* contaminated eggs. Of the 6 samples positives, one was shell and contents positive making a total of 7 distinct isolates recovered from the shell and contents of eggs sampled at catering premises (Table 2). All of the *Salmonella* isolates recovered were sensitive to the panel of antimicrobial agents used.

Table 2. *Salmonella* sero- and phage types recovered from raw shell catering egg shells and contents (n=7)

<i>Salmonella</i> sero/ phage types	No. positive shells pools	No. positive contents pools	Total positive pools
S. Enteritidis (all types)	5	1	6
S. Enteritidis PT4	3	1	4
S. Enteritidis PT 8	1	0	1
S. Enteritidis PT12	1	0	1
S. Mbandaka	1	0	1
Total	6	1	7

3.5 Production information of *Salmonella* positive samples.

Five of the *Salmonella* positive samples came from eggs produced within an assurance scheme (Lion Quality and Laid in Britain). Five of the six samples were contaminated with *S. Enteritidis* and were from caged hens. There was one sample which was contaminated with *S. Mbandaka* from free range hens. All *Salmonella* positives originated from different egg producers (Table 3).

Table 3. Information on the *Salmonella* contaminated egg samples from catering premises.

Country of origin	Assurance scheme	Stamp mark	Packing station code	Part of egg <i>Salmonella</i> detected	<i>Salmonella</i> sero / phage type
UK	Lion Quality	†3UK11063	Not known	Shells	S. Enteritidis PT4
UK	Not known	†3UK11462	UK/4/021	Shells	S. Enteritidis PT4
UK	Lion Quality	†3UK11043	UK/1/998W	Shells	S. Enteritidis PT12
UK	Laid in Britain	‡1UK15054	UK/6/548	Shells	S. Mbandaka
UK	Lion Quality	†3UK10641	Not known	Shells & Contents	S. Enteritidis PT4
Germany	Not known	†3DE0351631	Not known	Shells	S. Enteritidis PT8

† Caged egg production

‡ Free range egg production

3.6 Egg production methods and the presence of *Salmonella* spp.

The majority of the eggs sampled were labelled as caged (83.5%; n=1,326), with 10% (n=159) free range, 2.5% (n=40) barn and 0.1% (n=2) from organic hen systems (Table 4). The production details of 3.7% of the eggs sampled were not known due to lack of producer stamp or the stamp details being illegible. *Salmonella* spp. was detected in 5 of the cage eggs (0.4%) taken and one was from the free range (0.6%) production method.

Eggs of various sizes were sampled during the course of the survey, the majority of which were classed as medium (73.9%; n=1,174) and large (19.9%; n=316) (Table 4). Four of the *Salmonella* positive egg samples were from medium sized eggs (0.3%) and two from large sized eggs (0.6%).

3.6.1 Country of origin of catering eggs

The majority of eggs sampled originated from the UK (89%; n=1,413), with 7.4% (n=118) of the eggs being of non-UK origin (Table 4). A small proportion of the eggs did not have stamp details to identify the country of origin (1.1%). Of the *Salmonella* positive samples 5 were from eggs produced in the UK and 1 was from Germany.

3.6.2 Assurance schemes and the presence of *Salmonella* spp.

Sixty one percent of the eggs sampled (n=971) did not have information on assurance schemes available at the time of sampling (Table 4). Of the samples where this information was known (n=618), the majority of the eggs sampled were recorded to be from the Lion Quality (84%; n=519) and the Laid in Britain (11.2%; n=69) assurance schemes. Twenty seven samples came from hens which had been vaccinated against *Salmonella*, but the information provided did not allude to whether the eggs were produced according to any specific assurance schemes. Of the *Salmonella* positive pools, 3 came from Lion Quality produced eggs, 2 where the assurance scheme was unknown and 1 from the Laid in Britain scheme.

3.6.3 Condition of eggs from catering premises.

During the course of the survey the laboratory staff made a subjective decision on whether or not an egg was dirty (Annex E). If one egg within a group of eggs had visible signs of contamination then the whole group would be described as dirty. Through this classification process, the number of dirty eggs reported in this survey may be higher than is actually occurring in the egg market supply to the catering sector.

Over a fifth (21.1%) of the egg shells in the pooled samples were recorded as having a dirty appearance, i.e. visibly soiled and/or presence of hen faeces (Table 4). *Salmonella* spp. was detected from five (1.5%) samples that had dirty egg shells and one (0.1%) sample that had clean shells. There is a degree of

tolerance allowed for Grade A eggs and this is covered in Regulation (EC) 2295/2003, Article 33 (EC 2003b). At packing centres, Egg Marketing Inspectors (EMIs) may downgrade if quality faults exceed 5% of the samples checked from any single batch. At any other marketing stage (e.g. wholesale, retail, catering premises) an additional 2%, taking the tolerance up to 7% total, is permitted before EMIs may downgrade eggs. This subjective judgement is based upon the amount and type of contamination on the shell within a batch of eggs (EMI, personal communication).

Table 4. Production details of egg samples and *Salmonella* positive pools

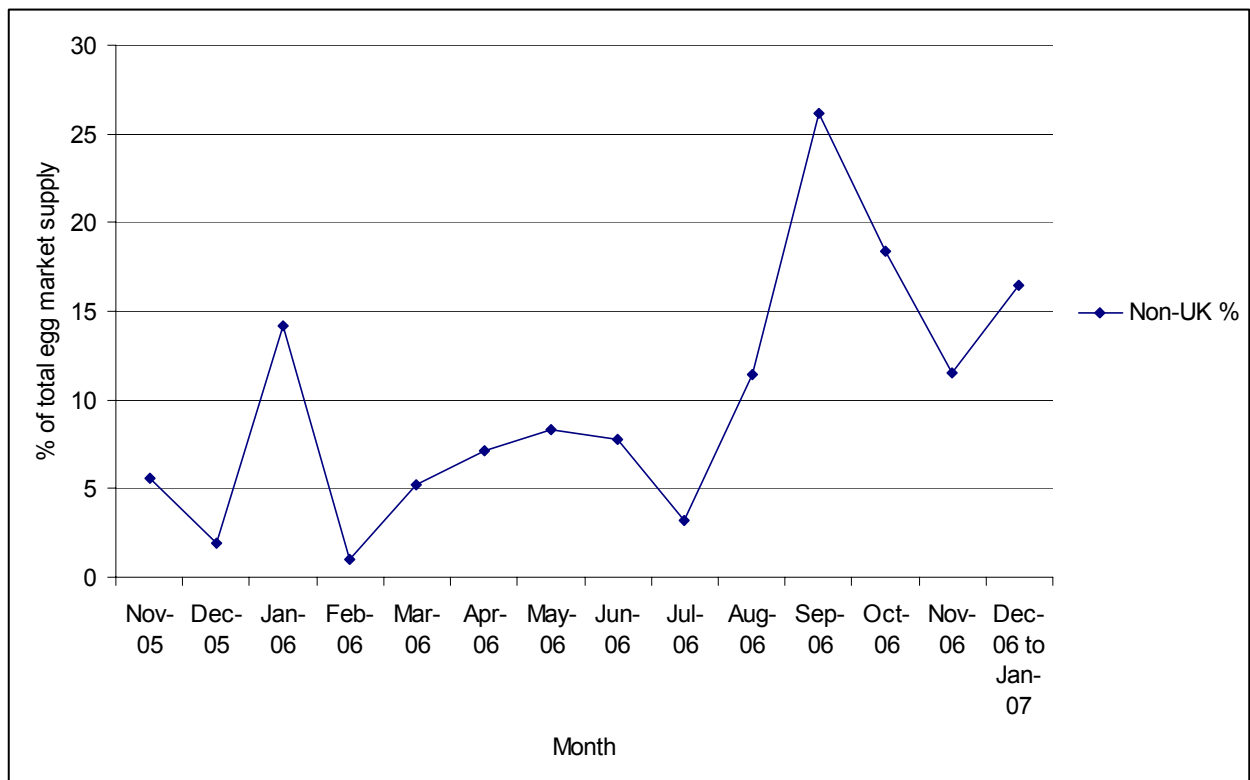
Egg details	Total No. pools of eggs examined (n=1,588)* (%)		No. pools <i>Salmonella</i> positive (n=6) (%)	
Country of origin:				
UK	1,413	(89.0)	5	(0.4)
Spain	48	(3.0)	0	
Germany	38	(2.4)	1	(2.6)
Netherlands	33	(2.1)	0	
France	27	(1.7)	0	
Portugal	8	(0.5)	0	
Republic of Ireland	1	(0.1)	0	
Poland	1	(0.1)	0	
Mixed origin: UK & Spain	2	(0.1)	0	
Not known	17	(1.1)	0	
Production type:				
Cage	1,326	(83.5)	5	(0.4)
Free Range	159	(10.0)	1	(0.6)
Barn	40	(2.5)	0	
Organic	2	(0.1)	0	
Mixed sample	3	(0.2)	0	
Not known	58	(3.7)	0	
Egg size:				
Small (<53g)	38	(2.4)	0	
Medium (53g - ≤ 63g)	1,174	(73.9)	4	(0.3)
Large (63g - ≤ 73g)	315	(19.9)	2	(0.6)
Extra large (≥ 73g)	9	(0.6)	0	
Other or Not known	52	(3.3)	0	
Assurance scheme:				
Lion Quality	519	(32.7)	3	(0.6)
Laid in Britain	69	(4.3)	1	(1.5)
Vaccinated against <i>Salmonella</i>	27	(1.7)	0	
Mixed sample: Lion Quality and Not known	3	(0.2)	0	
Not known	970	(61.1)	2	(0.2)
Condition of eggs:				
Clean	1,246	(78.4)	1	(0.1)
Dirty	335	(21.2)	5	(1.5)
Not stated	7	(0.4)		

* each sample comprised 6 eggs

3.7 Non-UK egg supply to the catering trade

In 2005, the majority of the UK's egg demand was met by the British egg producing industry (BEIS 2007). However, the non-UK imports sector continues to increase to meet the trade gap, be it only a small proportion of total raw shell egg consumption in the UK (Defra 2007). The catering sector comprises 23% and the retail sector 49% of the total UK egg market share. Figure 1 shows the fluctuation in the non-UK egg numbers sourced at the random catering premises visited during the course of the survey.

Figure 1. Proportion of non-UK eggs sampled at catering premises



3.8 Egg packing and shelf-life details of eggs from catering premises

3.8.1 Traceability of eggs sampled from catering premises

Most samples (94.0%) had a stamp mark on the egg shell, of which there were 485 different stamp marks. A small proportion of samples were either unmarked

(4.2%) or the stamp mark was illegible (0.9%), i.e. digits comprising some or all of the code of the farm where the eggs were produced were indecipherable. Stamp mark details were not recorded for 0.9% (Table 5). All six samples that had *Salmonella* spp. present were from eggs that had stamp mark details on the egg shell.

Over half the samples (54.6%) had a packing station number available (Table 5), of which there were 225 different packing station codes. Where these packing station details were unknown this was because the original packaging was not available. Information on packing stations was available for three of the six samples that had *Salmonella* present (Table 3), of which there were three different packing station codes.

Eggs used by caterers were in pack or case sizes ranging from six to 1,800, of which 1.1% and 5.4% were marked with a packing date and sell by date, respectively (Table 5). Where the packing and sell by date details were unknown this was because the original packaging was not available.

3.8.2 Shelf-life of eggs sampled from catering premises

According to Regulation 853/2004 on the hygiene of foodstuffs, eggs must reach the final consumer within 21 days from the date of lay (EC 2004), which means that eggs at catering premises should not have less than 7 days left before the best before date. The best before date of eggs must not exceed 28 days from the date of lay (EC 2003b, Annex E). The date was available for 67.3% (n=1,070) of eggs sampled (Table 5). For each of these samples, the number of days remaining (i.e. the number of days between the date sampled and the best before date) was determined (Table 5).

Best before dates were made available for 1,070 groups of 6 eggs. Over half of the samples had between 8 and 28 days remaining (53.3%; n=849) before expiration of the BBD. One tenth of the eggs (11.8%; n= 188) were used beyond

the 21 day limit where the eggs has to reach the final consumer. A small proportion of eggs samples (2.1%; n=33) were in use after their BBD (Table 5); these seemed to be in breach of the BBD requirements (i.e. must not exceed 28 days from lay) under Regulation (EC) No. 2295/2003 (Annex E) (EC 2003b).

Three of the six pools of eggs containing *Salmonella* spp. had seven or fewer days left of shelf-life. The Code of Practice on handling and storage of eggs from farm to retail sale (MAFF 1996a) recommends that a planned system of egg handling at caterers should be in place to ensure proper stock rotation.

Table 5. Traceability details and remaining days until eggs reach final consumer and *Salmonella* positive pools.

Egg details	Total No. pools of eggs examined (n=1,588)* (%)		No. pools <i>Salmonella</i> positive (n=6) (%)	
Stamp mark on shells:				
Marked	1,493	(94.0)	6	(0.4)
Illegible	15	(0.9)	0	
Not marked	66	(4.2)	0	
Not recorded	14	(0.9)	0	
Packing station code:				
Marked/Available	867	(54.6)	3	(0.4)
Not known	721	(45.4)	3	(0.4)
Pack size				
0-12	96	(6.0)	1	(1.0)
13-36	331	(20.8)		
37-72	167	(10.5)		
73-144	41	(2.6)		
145-360	648	(40.8)	3	(0.5)
>361	14	(0.9)		
Not known	291	(18.3)	2	(0.7)
Packing date:				
Available	17	(1.1)	0	
Not available	1,571	(98.9)	6	(0.4)
Sell by date:				
Available	86	(5.4)	0	
Not available	1,502	(94.6)	6	(0.4)
Best before date:				
Marked	1,070	(67.3)	5	(0.5)
Not marked [†]	518	(32.7)	1	(0.2)
Remaining days until best before date (n=1,070):				
22-28	74	(6.9)	0	
15-21	312	(29.1)	1	(0.3)
8-14	463	(43.3)	1	(0.2)
0-7 [‡]	188	(17.6)	3	(1.6)
<0 [‡] (expired)	33	(3.1)	0	

* each sample comprised 6 eggs

† No best before date on eggs or packaging

‡ Has not reached consumer within 21 days, in breach of Regulation 853/2004

‡ Has not been used before the BBD these have expired, in breach of Regulation 2295/2003

3.9 Catering premises details in relation to presence of *Salmonella* spp.

Definitions of catering premises provided within the sampling protocol (Annex C) and further defined (Annex H) were used to categorise the premises visited during the course of the survey. *Salmonella* spp. was detected from six samples of eggs collected from institutional caterers (1), fast food (1), restaurants (1), pubs (1) and in-store restaurants (2) visited (Table 6).

Cuisine served at catering premises was categorised using the definitions listed in Annex H. Most catering premises sampled served a general or mixed cuisine or traditional British or Irish meals (53.6%) (Table 6). Premises serving primarily sandwiches (sandwich bars, coffee shops etc.) and grilled/fried foods (burgers, kebabs, mixed grills etc.) accounted for 14% and 12% of the total respectively. Other national / ethnic cuisines made up 10% of the total, and of these half (5.2%) were Chinese restaurants and takeaways (Table 6).

Table 6. Catering premises details where egg samples were obtained and *Salmonella* positive pools

Parameter	No. catering premises (n=1,567)	(%)	No. pools* <i>Salmonella</i> positive (n=6)	(%)
Premises type:				
Fast Food	282	(18.1)	1	(0.4)
Café	279	(17.8)	0	
Restaurant	277	(17.7)	1	(0.4)
Hotel	208	(13.2)	0	
Pub	187	(11.9)	1	(0.5)
Institutional	169	(10.8)	1	(0.6)
In-store restaurant	84	(5.4)	2	(2.4)
Roadside catering	67	(4.3)	0	
Event caterer	10	(0.6)	0	
Transportation	4	(0.3)	0	
Type of cuisine:				
General/mixed	458	(29.2)	2	(0.4)
British/Irish	382	(24.4)	1	(0.3)
Sandwich/fried	219	(14.0)	0	
Grill/fried	188	(12.0)	1	(0.5)
Chinese	81	(5.2)	0	
Italian	25	(1.6)	1	(4.0)
European	12	(0.8)	0	
Indian	10	(0.6)	0	
Thai	7	(0.4)	1	(14.3)
Vietnamese	5	(0.3)	0	
French	4	(0.3)	0	
American	3	(0.2)	0	
Other (Greek, Japanese, Spanish, Swedish, Kosher, Seafood, Vegetarian)	10	(0.6)	0	
Not stated	163	(10.4)	0	

*, each sample comprised 6 eggs

3.10 Storage temperature and use of eggs at catering premises

Information on egg storage conditions were collected at the point of sampling. Over half of the catering premises visited stored raw shell eggs at ambient temperature (55.0%) (Table 7) and where recorded, this ranged from 9 to 30°C. *Salmonella* spp. was recovered from eggs stored at ambient (0.5%) and chilled (0.3%) temperature. Both the Code of Practice on handling and storage of eggs (MAFF 1996a) and the FSA Guidance on the use of eggs by caterers (FSA 2003)

recommend that eggs should be stored in a refrigerator. It should be noted that where ambient temperatures exceed 20°C, *Salmonella* is not restricted by the pH of the egg and is capable of surviving and multiplying (Cogan *et al.* 2003).

Table 7. Storage and use of eggs by catering premises and *Salmonella* positive pools

	No. catering premises (n=1,567)	(%)	No. pools* <i>Salmonella</i> positive (n=6)	(%)
Temperature shell eggs stored at:				
Chilled ($\leq 8^{\circ}\text{C}$)	618	(39.4)	2	(0.3)
Ambient ($> 8^{\circ}\text{C}$)	862	(55.0)	4	(0.5)
Not stated	87	(5.6)	0	
Multiple eggs broken, mixed and pooled together for use during the day:				
Yes	581	(37.1)	1	(0.2)
No	908	(57.9)	5	(0.6)
Not known	78	(5.0)	0	
Number of eggs pooled (n=581):				
<12	334	(57.5)	0	
12-36	194	(33.4)	1	(0.5)
>36	53	(9.1)	0	
Time pooled eggs are left before use (n=581):				
<2 hrs	474	(81.6)	0	
2 -<4 hrs	48	(8.3)	1	(2.1)
4-<6 hrs	24	(4.1)	0	
>6 hrs	27	(4.6)	0	
Not known	8	(1.4)	0	
Storage temperature of pooled eggs (n=581):				
Ambient	275	(47.3)	0	
Chilled	274	(47.2)	0	
Not known	32	(5.5)	1	(3.1)

*, each sample comprised 6 eggs

Eggs were broken, mixed and pooled prior to use in 37.1% of catering premises (Table 7). Of these, the number of eggs pooled were mostly less than 12 (57.5%)

or between 12 and 36 eggs (33.4%), and left for less than two hours before use (81.6%) at ambient (47.3%) or chilled (47.2%) temperature (Table 7). A detailed analysis of the time stored that pooled eggs are left before use at catering premises is provided in Table 8.

Table 8. Storage temperature and time pooled eggs left before use at catering premises (n=549)

Storage temperature of pooled eggs	Time pooled eggs are left before use	No. catering premises (%)	
Ambient (n=275)	<2 hrs	238	(86.6)
	2 -<4 hrs	22	(8.0)
	4-<6 hrs	8	(2.9)
	>6 hrs (not specified)	3	(1.1)
	Not known	4	(1.4)
Chilled (n=274)	<2 hrs	206	(75.2)
	2 -<4 hrs	25	(9.1)
	4-<6 hrs	15	(5.5)
	>6 hrs (7-72 hrs)	24	(8.7)
	Not known	4	(1.5)

Among the categories of catering premises visited, almost all carried out the practice of pooling eggs for use during the day, with half of institutional (50.9%), hotels (50.0%) and restaurants (47.3%) carrying out this practice (Table 9). This finding was significant when comparing institutional caterers, hotels and restaurants with all other catering premises visited ($p < 0.0001$). The practice of pooling eggs for use during the day and also at ambient temperature was shown to be predominant in those premises serving Chinese cuisine (77.8% pooled eggs, 40.7% pooled eggs stored at ambient) (Table 9). These findings were significant when comparing Chinese cuisine to general/mixed, British/Irish, sandwich/fried and grill/fried cuisines ($p < 0.0001$).

Table 9. Catering premises type and cuisine regarding the use of pooled eggs

Premises details	No. catering premises (n=1,567) (%)		No. pooling eggs for use during the day (%)		No. storing pooled eggs at ambient temperature (%)	
Premises type:						
Fast Food	282	(18.0)	87	(30.9)	43	(15.3)
Café	279	(17.8)	99	(35.5)	57	(20.4)
Restaurant	277	(17.7)	131	(47.3)	71	(25.6)
Hotel	208	(13.3)	104	(50.0)	30	(14.4)
Pub	187	(11.9)	43	(23.0)	14	(7.5)
Institutional	169	(10.8)	86	(50.9)	41	(24.3)
In-store restaurant	84	(5.4)	23	(27.4)	12	(14.3)
Roadside catering	67	(4.3)	11	(16.4)	8	(11.9)
Event caterer	10	(0.6)	4	(40.0)	2	(20.0)
Transportation	4	(0.2)	0		0	
Type of cuisine:						
General/mixed	458	(29.2)	175	(38.2)	68	(14.8)
British/Irish	382	(24.4)	150	(39.3)	66	(17.3)
Sandwich/fried	219	(14.0)	70	(32.0)	40	(18.3)
Grill/fried	188	(12.0)	47	(25.0)	25	(13.3)
Chinese	81	(5.2)	63	(77.8)	33	(40.7)
Italian	25	(1.6)	7	(28.0)	4	(16.0)
European	12	(0.8)	9	(75.0)	2	(16.7)
Indian	10	(0.6)	3	(30.0)	0	
Thai	7	(0.4)	3	(42.9)	1	(14.3)
Vietnamese	5	(0.3)	2	(40.0)	1	(20.0)
French	4	(0.3)	2	(50.0)	2	(50.0)
American	3	(0.2)	2	(66.7)	0	
Other (Greek, Mediterranean, Japanese, Spanish, Swedish, Kosher, Seafood, Vegetarian)	10	(0.6)	4	(40.0)	2	(20.0)
Not stated	163	(10.4)	51	(31.3)	34	(20.9)

4.0 Discussion

Raw shell eggs have continued to be implicated as a source or vehicle of *Salmonella* Enteritidis infection in outbreaks associated with commercial catering premises (HPA 2004) despite almost 20 years of national guidance on this issue (DH 1988a, 1988b, FSA 2003). No egg can be guaranteed to be free of *Salmonella* irrespective of its origin or production type. In this survey a total of 1,588 pooled samples of six eggs were collected from 1,567 catering premises, most of which were eggs produced in the United Kingdom (89%). The shell and contents of eggs were tested separately for the presence of *Salmonella*. *Salmonella* was isolated from six samples (0.38%) of eggs. Of these, five were *S. Enteritidis*, which were further characterised to phage types (PTs) as follows: PT4 (0.31%; n=3), non-PT4 (0.13%; n=2). *Salmonella* Mbandaka (0.06%; n=1) was also isolated. None of the *Salmonella* isolates exhibited antimicrobial resistance. Of the six *Salmonella* shell-positive samples, one was also contents-positive (*S. Enteritidis* PT4 detected in both). The small number of *Salmonella* shell positive samples may suggest random contamination from the production and packing environment to the egg shell.

A recent UK survey carried out in 2003 on catering eggs, of which most were of UK origin, uncovered a similar rate of *Salmonella* contamination of 0.30% (Elson *et al.* 2005). An examination of the surveys carried out in the UK on domestically-produced eggs from 1995 to 2003 illustrates the decline in *Salmonella* contamination of eggs, which is most likely to be due to the control measures introduced towards the end of the 1990s. Over the course of these eight years, the prevalence of *Salmonella* in UK hen eggs has declined threefold from 0.98% to 0.34% (FSA 2004a).

This decrease has been reflected by the fall in the overall incidence of *S. Enteritidis* contamination in UK produced eggs (England 1995/6; 0.82%, 2003; 0.28%) and especially *S. Enteritidis* PT4 (England 1995/6; 0.58%, 2003; 0.14%), (ACMSF 2001, FSA 2004a). The trend in the decline in *Salmonella*

contamination of eggs appears not to be reflected in a retail survey of non-UK eggs carried out in the UK in 2005/6. With the use of egg import data, a weighted estimated prevalence of 3.3% for *Salmonella* in non-UK eggs was found (Little *et al.* 2006).

Eggs sampled during the current survey were produced in eight European countries (France, Germany, Poland, Portugal, Republic of Ireland, Spain, The Netherlands, and the UK), with the majority (89%) originating from the UK. *Salmonella* spp. was detected from one (2.6%) and five (0.4%) egg samples that were produced in Germany and the UK, respectively. The *Salmonella* contaminated eggs from the UK were linked with five producers. The volume of eggs imported to the UK fluctuates throughout the year and closely reflects supply and demand. Although only a small proportion of the eggs sampled were of non-UK origin in this survey, the nature of the UK catering egg market may allow the sporadic introduction of highly contaminated eggs.

Class A eggs must be of a clean and undamaged appearance (EC 2003b), However, some eggs may have some slight faecal or similar dirt upon the shell on inspection; the Egg Marketing Inspectors (EMIs) have to make a subjective judgement to satisfy themselves that a batch of eggs is sufficiently dirty to be rejected. This subjective judgement is based upon the amount and type of contamination on the shell (EMI, personal communication). The laboratory staff referred to the strict description of a Class A egg and a fifth of eggs supplied to catering premises in this survey was found to have an unclean appearance.

Thirty-nine percent of egg samples used by caterers were produced from laying hens vaccinated against *Salmonella* or under a controlled assurance scheme. In the WHO/FAO risk assessment of *S. Enteritidis* in eggs, reducing the prevalence of *S. Enteritidis* in poultry flocks was directly proportional to the reduction in risk to human health (WHO/FAO 2002). Vaccination of layer flocks, or those certified as free from *S. Enteritidis* and *S. Typhimurium* under controlled assurance

schemes, combined with improved biosecurity, does appear to have had a significant impact on the prevalence of *S. Enteritidis* PT4 contamination of eggs and on human *Salmonella* infection (ACMSF 2001, Grein *et al.* 1997). Continued surveillance of human and veterinary salmonellosis is essential to detect emerging and future problems as demonstrated by the recent upsurge in *S. Enteritidis* non-PT4 infections in the UK and other European countries (Fisher 2004).

Food safety concerns in relation to use of eggs in catering include the failure to observe best before dates and/or the advice that eggs should be consumed within three weeks of lay (i.e. by the sell by date (EC 2004)), inappropriate storage temperature, the bulking or pooling of eggs prior to cooking, cross-contamination, the consumption of raw eggs (or uncooked dishes made from eggs), and in the case of vulnerable groups of people the consumption of lightly cooked eggs and egg dishes (ACMSF 2001). Combining refrigeration and good stock rotation is an easily achieved control measure to prevent low levels of salmonellae from achieving harmful population sizes. However, this survey showed that over half (55%) of the caterers did not store their eggs under refrigerated conditions, and a fifth (20.7%) of egg samples from catering premises had expired best before dates or were in use after three weeks of lay, and thus appeared not to practice good stock rotation. If present, *Salmonella* can grow rapidly in eggs stored at room temperature and growth is strongly governed by the age of the egg (Humphrey 1990, Humphrey and Whitehead 1993). The advantages of low temperature storage of shell eggs are that salmonellae are unable to multiply and the yolk membrane remains essentially intact for long periods of storage. This is particularly important in the commercial kitchen environment, where temperature fluctuations can accelerate changes to yolk permeability allowing invasion of yolk contents and multiplication of *S. Enteritidis*. Food safety guidance for caterers should also include storing eggs at or below 8°C.

Other high risk practices such as mixing and pooling shelled eggs for use during the day occurred in 37.1% of catering premises, with institutional caterers (50.9%), hotels (50.0%) and restaurants (47.3%) significantly more likely to carry out this practice ($p < 0.0001$). Pooling eggs and storage at ambient temperature was also shown to be significantly associated with those premises serving Chinese cuisine (77.8% pooled eggs, 40.7% stored pooled eggs at ambient temperature) ($p < 0.0001$). The Agency's Safer Food Better Business for Chinese cuisine advises that if eggs are pooled for later use that the liquid egg-mix should be stored in the refrigerator (FSA 2007). Food poisoning risks are multiplied where eggs contaminated with *Salmonella* are bulked with other eggs in catering as this makes contaminated raw material available to a large number of consumers, and also if kept in a warm kitchen environment increases the potential for multiplication of the organism. Cross-contamination can also occur during egg preparation, particularly when egg mixes are aerosolized during whisking, and especially when using an electric whisk. Once on surfaces, salmonellae can survive well (more than 24 hours) in dried batter or egg mixes (Humphrey *et al.* 1994). There is also evidence from outbreak investigations of survival of salmonellae on cooking vessels for prolonged periods of time after having been hand washed (HPA personal communication). Sagoo *et al.* (2003) has highlighted deficiencies in cleaning standards in food premises in the UK, including deficiencies in use of cleaning products, and the importance that effective cleaning schedules be established.

Evidence on poor egg storage and handling practices in catering premises from the present survey concurs with that reported in previous studies carried out in the UK (Elson *et al.* 2005) and the USA (Lee *et al.* 2004). Poor practice regarding use of eggs presents an unacceptable level of risk to the consumer. Taylor (2004) has also reported from a pilot study to investigate safe egg use in the UK catering industry that there is little awareness of food safety risks associated with eggs within the catering sector, for example using raw eggs in uncooked dishes and serving lightly cooked dishes containing egg to vulnerable

groups, that good practice is not widespread, that government guidance is not adhered to, and that traditional methods of communicating food safety information to caterers is not effective.

Caterers can reduce the risk of their customers becoming infected with *Salmonella* by ensuring that eggs are stored at or below 8°C, avoiding bulking or pooling of eggs not intended for immediate service, avoiding contamination of ready-to-eat foods from eggs, and ensuring that salmonellae are killed through proper cooking. Caterers should also pay close attention to egg stock rotation and refrigeration. A Code of Practice on the handling and storage of eggs recommends that food hygiene training for staff should include attention to the correct handling of eggs and foods containing eggs, and the avoidance of cross-contamination (MAFF 1996a). Taylor (2004) however identified the lack of specific advice on safe egg use in the Basic Food Hygiene Certificate, which is the major format for food hygiene training of food handlers to 'basic' (now foundation) level in the UK.

To protect the public's health, new approaches to reinforce advice about pasteurised egg use for raw egg dishes, refrigerated storage of eggs, and measures to prevent cross-contamination need to be considered. Increased awareness, through improved training of all food handlers and managers, may lead to an improvement in hygienic practices during handling of eggs and preparation of egg dishes in catering premises. These findings have implications for the food hygiene training for staff in the catering sector. However, there is high staff turn over in the catering sector and this will have implications on training staff and retaining the information.

The Agency's current advice to caterers and consumers is that cooking eggs properly will kill any vegetative bacteria (FSA 2003). This means that vulnerable groups (elderly, very young, pregnant women and the immunocompromised) should cook eggs until both the white and yolk are solid and when cooking dishes

that contain egg should do so until they are piping hot all the way through (<http://www.eatwell.gov.uk/healthydiet/nutritionessentials/eggsandpulses/eggs/>).

The Agency has also issued a leaflet for caterers on the use of eggs (<http://www.food.gov.uk/multimedia/pdfs/eggleaflet.pdf>). The Agency will consider the results of this survey along with those of other surveys (such as the survey on *Salmonella* contamination of non-UK eggs at retail sale) and the results of available research when considering its advice to caterers and consumers on egg consumption.

5.0 Conclusions

Salmonella spp. was isolated from six (0.38%) of 1,588 egg samples collected from 1,567 catering premises in the UK. Of the eggs sampled, most originated from the UK (89%). *Salmonella* spp. was detected from one (2.6%) and five (0.4%) egg samples that were produced in Germany and the UK, respectively. The *Salmonella* contaminated eggs from the UK and Germany originated from six producers.

Several areas regarding use of eggs, such as egg storage and stock rotation, potential for cross-contamination from mixing bulked eggs, and pooling of eggs not intended for immediate service were identified as risk areas. Further food hygiene training and advice to food handlers and caterers might reduce egg-associated *S. Enteritidis* infections.

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**Annexes to the Report of the Survey of *Salmonella*
Contamination of Raw Shell Eggs used in Catering Premises**

ANNEX A: LIST OF PARTICIPATING OFFICIAL FOOD CONTROL LABORATORIES

Country/Region	Official Food Control Laboratory
England – East	Chelmsford*, Norwich†
England – East Midlands	Lincoln†, Leicester†
England – London	London*
England – North East	Newcastle*
England – North West	Carlisle†, Chester†, Preston†
England – South East	Wessex Environmental Microbiology Services*
England – South West	Bristol*, Exeter†, Gloucester†, Plymouth†
England – West Midlands	Birmingham*, Hereford†, Shrewsbury†, Stoke†
England – Yorkshire & Humber	Hull†
Wales	NPHS‡ Bangor, Cardiff, Carmarthen, Rhyl
Scotland	Aberdeen PA§, Dundee PA§, Edinburgh PA§, Glasgow PA§,
Northern Ireland	Northern Ireland Public Health Laboratory

*, Health Protection Agency (HPA); †, HPA Collaborating Laboratory; ‡, National Public Health Service-Wales; §, Public Analyst

ANNEX B: LIST OF PARTICIPATING LOCAL AUTHORITY ENVIRONMENTAL HEALTH DEPARTMENTS

England (n=179)

Allerdale, Alnwick, Babergh, Barnet, Barrow, Basildon, Basingstoke & Deane, Bedford, Berwick-upon-Tweed, Bexley, Birmingham, Blaby, Blyth Valley, Boston, Bournemouth, Bracknell Forest, Brent, Bromley, Broxbourne, Bury, Camden, Cannock Chase, Carlisle, Castle Morpeth, Castle Point, Charnwood, Chelmsford, Cheltenham, Cherwell, Chester, Chester-le-Street, Chichester, Chiltern, Chorley, Christchurch, Colchester, Congleton, Copeland, Cotswold, Crewe & Nantwich, Dacorum, Darlington, Derwentside, Durham, Easington, Eastleigh, East Cambridgeshire, East Devon, East Hampshire, East Lindsay, East Riding of Yorkshire, East Staffordshire, Eden, Ellesmere Port & Neston, Enfield, Epping Forest, Fareham, Fenland, Forest of Dean, Gateshead, Gloucester, Gosport, Great Yarmouth, Greenwich, Hackney, Halton, Hambleton, Harrow, Hartlepool, Havant, Herefordshire, Hillingdon, Hull & Goole Port Health, Huntingdonshire, Isle of Wight, Islington, Kingston upon Hull, Knowsley, Lancaster, Lewisham, Lichfield, Lincoln, Liverpool, Luton, Macclesfield, Malvern Hills, Manchester, Mid Bedfordshire, Middlesbrough, Milton Keynes, Newcastle under Lyme, Newcastle upon Tyne, New Forest, Newham, North Devon, North East Lincolnshire, North Hertfordshire, North Kesteven, North Lincolnshire, North Norfolk, North Somerset, North Tyneside, Norwich, Oadby & Wigston, Oldham, Oxford, Peterborough, Plymouth, Poole, Portsmouth, Preston, Purbeck, Reading, Redcar & Cleveland, Redditch, Richmondshire, Richmond upon Thames, Rochdale, Rochford, Rossendale, Rutland, Ryedale, Salford, Scarborough, Sefton, Slough, Southampton, Southend-on-Sea, South Buckinghamshire, South Gloucestershire, South Holland, South Kesteven, South Lakeland, South Norfolk, South Oxfordshire, South Staffordshire, South Tyneside, Stafford, Staffordshire Moorlands, Stevenage, St Edmundsbury, St Helens, Stockton, Stockport, Stoke-on-Trent, Stroud, Suffolk Coastal, Sunderland, Sutton, Swindon, Tamworth, Teesdale, Teignbridge, Tendring, Test Valley, Tewkesbury, Torbay, Torridge, Tower Hamlets, Tynedale, Uttlesford, Vale of White Horse, Vale Royal, Waltham Forest, Wandsworth, Warrington, Welwyn & Hatfield, West Berkshire, West Dorset, West Lindsey, Weymouth & Portland, Wigan, Winchester, Wirral, Wokingham, Worcester, Wychavon, Wyre Forest, Wycombe.

Wales (n=18)

Blaenau Gwent, Caerphilly, Cardiff, Carmarthenshire, Ceredigion, Denbighshire, Flintshire, Gwynedd, Merthyr Tydfil, Monmouthshire, Neath & Port Talbot, Pembrokeshire, Rhondda Cynon Taff, Swansea, Torfaen, Vale of Glamorgan, Wrexham, Ynys Mon.

Scotland (n=25)

Aberdeenshire, Angus, Argyll & Bute, Clackmannanshire, Dumfries & Galloway, Dundee, East Ayrshire, East Dunbartonshire, East Lothian, East Renfrewshire, Edinburgh, Falkirk, Glasgow, Highland, Inverclyde, Midlothian, North Ayrshire, Perth & Kinross, Renfrewshire, Shetland Isles, South Ayrshire, South Lanarkshire, Stirling, West Dunbartonshire, West Lothian.

Northern Ireland (n=16)

Antrim, Ards, Armagh, Ballymena, Ballymoney, Banbridge, Belfast, Carrickfergus, Coleraine, Cookstown, Craigavon, Dungannon & South Tyrone, Fermanagh, Larne, Magherafelt, Newtownabbey.

**ANNEX C: FOOD STANDARDS AGENCY SURVEY OF *SALMONELLA*
CONTAMINATION OF RAW SHELL EGGS USED IN CATERING PREMISES:
PROTOCOL**

**SURVEY OF *SALMONELLA*
CONTAMINATION OF RAW SHELL EGGS
USED IN CATERING PREMISES**

PROTOCOL

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1. Proposed timetable
2. Definition of a Class A egg and egg stamping requirements
3. Definitions of catering premises
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OUTLINE

Background

1. Between 1981-1991 the number of cases of salmonellosis in the UK in humans rose by approximately 170%. In March 1991, the Advisory Committee on the Microbiological Safety of Food (ACMSF) agreed to set up a working group to consider the extent to which eggs were responsible for this pandemic. The *Salmonella* in eggs working group concluded that much of the rise in human salmonellosis was due to *Salmonella* Enteritidis, mostly phage type 4 (PT4), which can invade the reproductive tract of a chicken.¹ This work coincided with the publication of a Department of Health (DH) funded survey² of the prevalence of *Salmonella* contamination of individual eggs from high street retailers, which indicated a contamination rate of 1 in 108 boxes of 6 eggs on either the shell and/or in the contents in UK eggs.
2. A further survey on UK produced eggs in 1995/96 suggested little improvement, with *Salmonella* being present in 1 in 101 boxes of 6 eggs.³ However, a more recent survey in 2003 of UK eggs on retail sale showed a reduction in *Salmonella* contamination to 1 in 290 boxes of 6 eggs.⁴ This has been accompanied by a large decreased in the number of cases of human infection caused by *Salmonella* Enteritidis PT4.
3. Some data are available on *Salmonella* contamination of shell eggs in catering premises. In 1991, a DH funded survey of imported eggs at the port of entry was carried out by the PHLS. The *Salmonella* prevalence was 1.6% from 8,630 samples of six eggs. Out of the total number of salmonellas, 13.8% were *S. Enteritidis* and 11.6% were *S. Enteritidis* PT4. In 1996/97, the Department of Health (DH) carried out a further survey, comprising 1,433 samples of 6 non-UK shell eggs taken from importers. The study found the prevalence of *Salmonella* in non-UK eggs to be 1 in 49 boxes of 6 eggs. The survey found that the total *Salmonella* prevalence was 2.0%. Out of the total

¹ Advisory Committee on the Microbiological Safety of Food (1993). Report on *Salmonella* in eggs. HMSO, London.

² De Louvois, J. (1993). *Salmonella* contamination of eggs. Lancet; **324**: 366-367.

³ Advisory Committee on the Microbiological Safety of Food (2001). Second report on *Salmonella* in eggs. HMSO, London.

⁴ Food Standards Agency Report of the survey of *Salmonella* contamination of UK produced shell eggs on retail sale. March 2004

⁵ Elson R, Little CL, Mitchell RT (2003) LACORS/Health Protection Agency Co-ordinated Food Liaison Group Studies: Microbiological Examination of Raw Shell Eggs and their Use in Catering Premises

number of salmonellas, 62% were *S. Enteritidis* and 7% were *S. Enteritidis* PT4. In two of the samples *Salmonella* was isolated from the shell and contents. The results from these surveys suggest that there had been little improvement in *Salmonella* contamination of these non-UK eggs. The HPA/LACORS network in 2003 carried out a survey of eggs (including duck and other species) used in catering premises.⁵ The survey collected both UK (88%) and non-UK eggs (12%) from premises not previously linked to outbreaks. The prevalence of *Salmonella* in catering eggs was 0.3%.

Objectives

4. The primary objective of the survey is to determine the level of *Salmonella* contamination of raw shell eggs at catering premises within the UK.
5. It should be noted that this survey focuses on eggs used in catering premises within the UK and is not intended to provide information on seasonality or prevalence within countries. Environmental health officers will take samples at various catering premises over a period of 12 months. As far as possible, the aim will be to identify the country of origin of all eggs tested and the source of all *Salmonella*-positive eggs. Production types of the eggs will be recorded. However, the survey will not be able to collect enough samples of less common production types to make statistical comparisons.

Publication of results

6. The FSA has a policy of openness and releases all details associated with samples analysed in its surveys including vaccination schemes, brand names, packing station codes and the company names and addresses of catering premises. The Agency will not withhold further information collected in association with this survey if, after due consideration, it considers this to be in the public interest. At the end of the survey, the results and all the information that has been collected about the samples will be published on the Agency's website.

Timetable

7. A proposed timetable is available at Annex 1.

SURVEY DESIGN

8. The main objective of the survey is to determine the level of *Salmonella* contamination of raw shell hen eggs used within the catering trade (see Annex 3 for definitions of various catering trades). The required number of eggs to be tested to achieve this objective depends on the degree to which the rate of contamination has changed. Since this is unknown, the decision has been taken to start by testing 1,600 samples over a period of 12 months. The results will be assessed and if the sample is not large enough to demonstrate a statistically significant prevalence, sampling will be extended.
9. The contractor will be responsible for ensuring that the appropriate number of samples (as outlined in Annex 4) is collected. Seasonal effects are not being investigated; therefore it is acceptable for the contractor to sample catering premises region by region rather than continually sampling throughout the UK. Catering premises should not be sampled more than once to enable a variety of samples and premises to be selected. If the samplers are unsure of the production type or country of origin, the eggs should not be sampled.
10. The aim of this survey is to sample 1,600 composites of 6 eggs. The number of samples should be reviewed by the Agency every month to ensure that enough eggs are being sampled to meet the required quota.
11. Caterers should receive payment for the eggs at the time of sampling. The contractors will be responsible for organising this payment.
12. Contractors should provide caterers with a letter from the Agency informing them that samples have been taken from their premises in order to carry out a survey (Annex 6).

SAMPLING

Sample collection

13. It is essential that cross-contamination be avoided during collection of eggs. Precautions must therefore be taken at all stages to ensure that the equipment used during sampling, transport and storage is not contaminated with *Salmonella*.
14. Eggs sold for human consumption should be of Class A quality (see Annex 2 for definition of Class A). Should the contractor find eggs in breach of Class A standards or egg marketing regulations they should report these findings to the FSA on an informal basis who in turn will contact the relevant authorities for further investigations. The contractor/sampler should inform the Trading Standards Officer to make them aware of eggs in breach of egg marketing regulations. Contractors should collect samples at random from the boxes/trays using gloved hands. As there is no available scientific evidence that there is an association between size of egg and prevalence of *Salmonella* there is no need for samplers to select specific sizes. The temperature of the eggs should be recorded, as should information on whether they were stored in a temperature controlled environment e.g ambient or chilled cabinet
15. Class A eggs should not be cracked, however, eggs may become cracked during transit. **Cracked eggs may be sampled, to enable a comparison between intact and cracked eggs, but a note of this must be made on the sampling form.** Where cracked eggs are sampled a contingency sample must be taken to ensure enough samples are collected and acceptable for testing i.e. not broken. Samplers should aim to sample hen eggs without discrimination of country of origin to reflect what is used in the catering industry as a whole. On occasion it may be possible for catering boxes of eggs to contain eggs collected from more than one farm. Composites of eggs should have the same egg stamp to indicate that they are from the same farm. If the box contains eggs from more than one farm, samples should be taken to reflect this variation of samples. The eggs should be placed in a sanitised box, which must then be placed in a separate sampling bag to avoid the risk of cross contamination during transport and storage.
16. Contractors should set in place a contingency plan to ensure enough samples are collected (e.g. to allow for any eggs broken in transit).
17. Contractors should ensure that samples are kept at approximately 20°C during transportation. Samples should be kept dry and out of direct sunlight in a cool-box. A calibrated data logger should be placed with the samples to monitor compliance with these requirements to ensure that samples were not stored above 25°C.

Sample information

18. All relevant information available from the sample should be entered onto a sampling form. As far as possible this information should include date and time of sampling, property name, property number, street name and postcode, packing station code, vaccination scheme, organic reference number, egg stamp code (to include country, production type and farm code), size, best before date and brand name (address of packer / producer, sell by date and packing date should also be recorded if available). The contractor will also enter this data onto an Excel 97 spreadsheet.
19. Each sample should be given a unique identification number that includes letters (e.g. EF2000 England, Free range) in order to clearly link to a particular sample. This reference number should be retained throughout testing and when any isolates are sent for typing.

TESTING

Receipt of samples

20. On receipt of the samples, laboratories should complete a laboratory record form to record details of LIMS number, appearance, country code, production code, and farm code.
21. A digital photograph of high resolution should be taken of the egg stamp and stored on a CD-ROM as a JPEG file under the appropriate sample number. The photograph should be of a high resolution so that the stamping / labelling details are clear.
22. Eggs should reach the laboratory within 24 hours of sampling. Eggs should be held at approximately 20°C and the laboratory sampling procedure should begin within 24 hours of arrival at the laboratory.

Examination

23. Eggs should be examined visually before testing to confirm and record the absence or presence of cracks. If any marks (e.g. faecal material, dust, mud, blood and the contents of other eggs) other than natural markings or printed marks are present eggs will be considered dirty.
24. It is essential that handlers take care to avoid cross contamination between sample boxes and from the surrounding environment at all stages (e.g. by wearing gloves and changing them between each sample of six eggs). Thorough cleaning of equipment and work surfaces must be undertaken regularly. There must be regular environmental sampling of the laboratory for *Salmonella* prior to and after egg testing. The contractor should carry out examination in areas dedicated to the examination of survey samples and clearly separated from potentially contaminated materials such as meat, chicken or faecal samples. It is also important that the laboratory control strain should be a rare serotype of *Salmonella*, not associated with the contamination of eggs.

Salmonella methodology

25. The methodology for *Salmonella* testing is set out in Annex 5. The method used is similar to that of the last survey in which shell and contents were tested separately. However, it should be noted that there is no method currently in existence that satisfactorily distinguishes shell from content contamination and the result will therefore be reported as a rate per group of six eggs as in previous egg surveys. Separate data for shell and contents contamination will be included as an annex in the report.

Data handling and reporting

26. At monthly intervals, the contractor will submit to the Agency a summary report containing details of the samples collected to date.
27. An interim report (electronic and hard copy) containing a summary of the results to date will be submitted to the Agency at bi-monthly intervals. The contractor will be expected to incorporate into their spreadsheet data on serotyping and phage typing for any *Salmonella* isolates sent for typing.
28. The contractor is responsible for collating all the results and a final report will be submitted to the Agency once the survey has been completed. The report will present summary statistics on the prevalence of *Salmonella*, together with a breakdown of the serotype and phage types. The contractor should not subject the results to detailed statistical analysis, as this will be undertaken by the Agency's statisticians.
29. The contractor must retain all forms, documentation and electronic files until further notice from the Agency in case of issues arising after completion of the survey. It is not necessary to provide the FSA with hard copies of forms. However, this information must be made available to the FSA if required.

Quality assurance

30. In order to ensure a high level of accuracy in data entry, checking and back up of information must be accredited by an appropriate organisation (e.g. UKAS). The contractor must also be able to demonstrate satisfactory performance in the testing of food for *Salmonella* through participation in an external proficiency-testing scheme (e.g. HPA, FEPAS). This should include the testing of External Quality Assessment samples by a different technician on three occasions throughout the survey. The FSA will visit the contractors during the course of the survey to assess how the work is being carried out.

Zoonoses Order 1989

31. Under the Zoonoses Order 1989, laboratories, which isolate *Salmonella* from foodstuffs, must provide Defra with a listing of subtype found together with the name of the premises where the eggs were obtained.

ANNEXES

ANNEX 1: PROPOSED TIMETABLE

6 April 2005	Request for Expressions of Interest
20 May 2005	Protocol finalised
23 May 2005	Request for full bids
13 June 2005	Appraisal of full bids
24 June 2005	Contractor finalised
4 July 2005	Contract signed
1 October 2005	Contract and sampling starts
1 December 2005	First interim report
1 November 2006	End of sampling and testing period
1 December 2006	Final report received
Mid 2007	Final report published

ANNEX 2: DEFINITION OF A CLASS A EGG AND EGG STAMPING REQUIREMENTS

The regulations specify the minimum characteristic for quality classes. Class A eggs must have a normal shell cuticle which is clean and undamaged, the egg must be free of foreign smells and wet or dry clean is not permitted. Raw shell eggs sold for human consumption should be of Class A quality. A 28 day best before date is the legal maximum in order for the egg to retain its Class A qualities. It should also noted that all eggs must reach the consumer within a maximum of 21 days of being laid or at least 7 days prior to the declared best before date (28 days maximum from lay) whichever is the sooner.

From effect of 1 January 2004 a code indication the producers unique distinguishing number must be printed on all Class A eggs eg: 1UK12345. The distinguishing number includes an indication of origin and method of production. The stamp must be legible letters and figures at least 5mm high in food grade ink indelible and resistant to boiling. As of 1 July 2005, small producers selling ungraded eggs are required to stamp eggs.

Eggs not reflecting the above criteria are in breach of the egg marketing regulations.

ANNEX 3: DEFINITIONS OF CATERING PREMISES

Definitions sourced from Mintel to cover the commercial and retail catering market

Fast food:

- Burger bars
- Pizza restaurants, takeaway and home delivery outlets
- Pasta chains
- Chicken fast food chains
- Fish and chip shops.
- Other types of fast food such as jacket potatoes, sausages, vegetarian specialities, filled croissants.

Pub catering: including food served from the bar and in pub restaurants chains.

Independent and chain restaurants

In-store restaurants Hotel catering: including hotel restaurants, bar and room service.

Other catering including cafes, coffee shops and other retail outlets.

ANNEX 4: SAMPLING PLAN

A sample size of approximately 1,600 composites of 6 eggs is needed to achieve the precision required. The sample numbers should be reviewed periodically to ensure that statistically significant analyses could be carried out. The sampling plan may be adjusted at a review point of the survey to adjust sampling figures to enable some comparison between UK and non-UK eggs.

This is based on the following:

If the prevalence of contaminated boxes is close to 1% (i.e one box in 100 contains at least one contaminated egg) with a +/- 25% error in a 95% confidence interval (CI) could measure prevalence levels between 0.75% -1.25%.

Country	Number of samples to be taken
England	1,389
Scotland	102
Wales	75
Northern Ireland	34
Total	1,600

Minimum Number of Samples Collected per Month per Region

Country/Region	Laboratory	Minimum samples/Month	Samples/12 Months
England – East	Chelmsford Norwich	7	84
		6	72
		13	156
England – East Mids	Lincoln Leicester	7	84
		6	72
		13	156
England – London	London	10 10	120 120
England – North East	Newcastle	13 13	156 156
England – North West	Carlisle Chester Preston	2	24
		5	60
		6-7	78
		13-14	165
England – South East	WEMS	13 13	156 156
England – South West	Bristol Exeter Gloucester Plymouth	2	24
		3	36
		5	60
		3	36
		13	156
England – West Mids	Birmingham Hereford Shrewsbury Stoke	4	48
		2	24
		4	48
		4	48
		14	168
England – York & Humber	Hull	13 13	156 156
England – Grand Total			1389
Wales - NPHS	Bangor Cardiff Carmarthen Rhyl	1-2	18
		1-2	19
		1-2	19
		1-2	19
		4-8	75
Scotland - PAs	Aberdeen Dundee Edinburgh Glasgow	1-2	16
		1-2	16
		2-3	28
		3-4	42
		7-11	102
Northern Ireland PHL	Belfast	2-3 2-3	34 34
			1600

ANNEX 5: LABORATORY METHODOLOGY

Sampling procedure

Wear suitable single-use gloves for handling the eggs, changing the gloves after each batch of six eggs.

Aseptically break open the eggs and separate shell from contents, taking care to avoid contaminating the contents with pieces of shell. If a portion of shell contaminates the contents this sample should be discarded.

For contents: Add the content of six eggs to a sterile stomacher bag (~180mm x 300mm) or a large screw top container placed on a gravitational diluter (programmed for 50:50 dilution with buffered peptone water (BPW) Add a small amount of BPW and stomach or shake well the eggs for 1 minute. Add further BPW to create a 50:50 dilution. Holding the top of the stomacher bag closed, mix the sample well, seal the bag with a clip and incubate the stomached sample for 18-20h at 37°C ± 1°C.

For shells: Add the shells to a doubled stomacher bag (~180x 3000mm) Place on the gravitational diluter (programmed for 50:50 dilution with BPW). Add BPW to create a 50:50 dilution, crush the shells down gently. Mix the sample, seal the bag and incubate the stomached sample for 18-20 h at 37°C ± 1°C.

Test procedure

- a) Add 0.1 ml of the inoculated BPW to 10 ml Rappaport-Vassiliadis Soya Peptone Broth (RVS) and incubate at 41.5°C ± 1°C for 24 h.
- b) Also, add 1 mL of the same pre-enrichment culture to 10 mL of Muller-Kauffmann tetrathionate novobiocin broth (MKTTn). Place in an incubator at 37°C ± 1°C for 24 hours.

After selective enrichment streak a 10µl loop onto modified Brilliant Green Agar (mBGA) and Xylose Lysine Desoxycholate agars (XLD). Incubate plates for 24 h at 37°C ± 1°C. Colonies on mBGA: red/pink or white opaque colonies with brilliant red/pink zone, on XLD: red with black centre. Re-incubate those plates with no *Salmonella* colonies for a further 22 ± 2 hours, and re-examine for the presence of typical *Salmonella* colonies.

Confirmation

Perform appropriate biochemical tests for *Salmonella* on typical or suspect colonies (3 of each type from each sample) from both mBGA and XLD plates. Isolates showing typical *Salmonella* biochemical reactions should be tested with polyvalent antisera for typical O and H antigens.

Send 3 isolates of each *Salmonella* type on a nutrient agar slope to the Laboratory of Enteric Pathogens, HPA, Colindale for confirmation, serotyping, phage typing, antibiotic susceptibility testing and archiving.

ANNEX 6 LETTER TO CATERERS

Letter to be Sent to Caterers During Sampling

Insert Council Logo &/or Name

<Date>

Dear

This letter has been given to you by an Environmental Health Officer (EHO) from [insert name of council] Council.

The EHO is authorised by the Council to carry out food sampling work, and has purchased eggs from your premises as a food sample, which is to be used for a food surveillance survey.

The aim of this particular survey is to produce an ongoing estimate of the *Salmonella* contamination in eggs used in catering establishments in the UK. Groups of 6 eggs are being sampled and tested during a 12-month period.

This survey is funded by the Food Standards Agency who has commissioned the Health Protection Agency and the LACORS network to carry out the sampling.

Your premises has been visited as one of the catering establishments where eggs are used - the subject of this survey. The eggs purchased from your premises will be taken to [insert name of lab] for testing, and you will be provided with the results of this testing by a letter from the Food Standards Agency. Please note that the survey is not for enforcement purposes. If a sample is found to be positive, a member of the environmental health team may visit your premises to provide advice on the safe storage and preparation of eggs in the interests of public health.

The results of the samples taken in this survey will be collated and will form part of a report on the incidence of *Salmonella* in raw shell eggs used in catering premises within the UK. This report will be published by the Food Standards Agency. At the end of the survey, in line with Food Standards Agency policy on openness and transparency in relation to food safety and matters of interest to consumers relative to food, a list of the individual catering establishments along with details of the eggs sampled will be published on the Agency's website www.food.gov.uk as part of this report.

Should you have any queries, please contact Dr Chun-Han Chan, Microbiological Safety Division on the following telephone number: 0207 276 8957 or send an E-mail to Chun-Han.Chan@foodstandards.gsi.gov.uk.

Yours sincerely

**ANNEX D: FOOD STANDARDS AGENCY SURVEY OF *SALMONELLA*
CONTAMINATION OF RAW SHELL EGGS USED IN CATERING PREMISES:
SAMPLING FORM**

Sampling form - Catering eggs survey



SAMPLER USE ONLY

Catering premises details

Sampler name Sampler contact no.
 Sample ref no. Local authority
 Name of premises number and address
 Postcode
 Premises type: Fast food Pub Hotel Restaurant
 Roadside catering In-store restaurant
 Other please specify
 Please specify type of cuisine
 Egg use: do you break, mix and pool multiple eggs for use during the day? Yes No
 If Yes: how many eggs do you pool? <12 12-36 >36 (please specify)
 how long are the pooled eggs left before use? <2hrs 2-<4hrs 4-<6hrs
 >6hrs (please specify)
 are the pooled eggs stored at ambient temperature? Yes No

Sample details - Part 1

Sampling date	<input type="text"/>	Ambient	Chilled
Sampling time	<input type="text"/>	Storage temperature (°C)	
Egg size:	Small <input type="checkbox"/>	Medium <input type="checkbox"/>	Large <input type="checkbox"/>
	Other <input type="checkbox"/>	please specify <input type="text"/>	
Country	<input type="text"/>	Packing station code <input type="text"/>	
Vaccination scheme	<input type="text"/>		
Sell by date	<input type="text"/>	Packing date <input type="text"/>	
Production type	<input type="text"/>	Organic ref. number <input type="text"/>	
Brand name / Packer / producer name (if applicable)	<input type="text"/>		
Address of packer/producer	<input type="text"/>		
	Postcode <input type="text"/>		
Pack size	<input type="text"/>	Best before date <input type="text"/>	

Continued overleaf ...

Comments

The results of the sample will be sent by the co-ordinating centre to the Microbiological Safety Division at the Food Standards Agency. You will be notified by the testing laboratory and the Food Standards Agency of any Salmonella positive results

If you require information in regard to this survey please contact:

Dr Christine Little
Health Protection Agency Centre for Infections
Environmental & Enteric Diseases Department (CDSC)
61 Colindale Avenue
London NW9 5EQ
Telephone: 0208 327 7931
E-mail: christine.little@hpa.org.uk

LABORATORY USE ONLY

Sample details - Part 2

Condition of eggs

(sample of 6 eggs): Clean Dirty Cracked
Other please specify

Comments

Photograph of egg taken? Yes No

Stamp i.e. AB 1 123 / marking on egg shell

Appearance / condition of eggs: Acceptable Unacceptable

Date received / checked LIMS number

Microbiological Results

Shell: Salmonella spp. positive Salmonella spp. negative

Contents: Salmonella spp. positive Salmonella spp. negative

Sent for serotyping? Yes No Date

Comments

ANNEX E: DEFINITION OF A CLASS A EGG, EGG STAMP MARK REQUIREMENTS, AND ARTICLE 33 OF REGULATION (EC) 2295/2003 – TOLERANCE FOR QUALITY DEFECTS

Regulation EC No 2295/2003 specifies the minimum characteristic for quality classes. Only Class A eggs are sold for human consumption. Class A eggs must have a normal shell and cuticle which is clean and undamaged; an air cell not exceeding 6mm in depth; a clear, translucent, gelatinous egg white; a stationary yolk which is visible under candling as a shadow only; be free of foreign substances; be free of extraneous odours; and washing or cleaning by any other means is not permitted. The legal maximum 'best before' date for Class A eggs is 28 days from date of lay. In addition to the 'best before' date, the recommended sell-by date shall not exceed the maximum time limit of 21 days from the date of lay (EC 2003b; EC No 853/2004¹), i.e. eggs must be sold to consumers within a maximum of 21 days of being laid or at least 7 days prior to the declared best before date (28 days maximum from lay) whichever is the sooner (MAFF 1996a).

From 1 January 2004, Council Regulation EC No 5/2001 requires all Class A eggs placed on the market within the EU to be marked with a code identifying the production establishment, country of origin and farming system (i.e. organic, free range, barn or cage) (EC 2001). The stamp mark must consist of legible letters and figures at least 5mm high in food grade ink indelible and resistant to boiling. The introduction of stamp marking on egg shells improves consumer information, choice, and assists in traceability of eggs placed on the market for human consumption.

Egg stamp mark codes are in the format X.YY.12345, where:

-
- ¹ Regulation (EC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for food of animal origin. Official J European Union **L226**, 22-82

X is a digit representing the farming method, e.g. 0=Organic, 1=Free Range, 2=Barn, 3=Cage.

YY are letters representing the country of origin, e.g. AT=Austria, BE=Belgium, CY=Cyprus, CZ=Czech Republic, DE=Germany, DK=Denmark, EE=Estonia, ES=Spain, FI=Finland, FR=France, GR=Greece, HU=Hungary, IE=Ireland, IT=Italy, LV=Latvia, LT=Lithuania, LU=Luxembourg, MT=Malta, NL=Netherlands, PL=Poland, PT=Portugal, SE=Sweden, SK=Slovakia, SI=Slovenia, UK=United Kingdom.

12345 are digits representing the unique identification number of the farm.

Eggs not reflecting the above criteria are in breach of the egg marketing regulations.

Article 33 of Regulation (EC) 2295/2003 Tolerance for Quality Defects

1. The following tolerances shall be allowed in the checking of batches of Class A eggs and washed eggs:

- (a) at the packing centre, just before dispatch: 5 % of eggs with quality defects,
- (b) at the other marketing stages: 7 % of eggs with quality defects.

However, in the checking of eggs marketed as "extra" no tolerance shall be allowed for the height of the air space either at the time of packing or import.

2. Where the batch checked contains fewer than 180 eggs, the percentages referred to in paragraph 1 shall be doubled.

ANNEX F: EGG PRODUCTION SYSTEMS

Information on egg production systems has been provided by Defra and is published at <http://www.defra.gov.uk/foodrin/poultry/faq/marketing.htm>

Cage

A cage system consists of tiers of cages. The cages have sloping mesh floors so that the eggs roll forward, out of the reach of the birds to await collection. For each cage there must be at least 10cm of feed trough/bird and at least two drinkers/cage or 10cm of drinking trough/bird. Droppings pass through the mesh floors onto boards, belts or into a pit to await removal. A minimum of 550cm squared per bird is required in standard cages, which were installed prior to 2003.

Since 2003 only installation of enriched cages are allowed, with a minimum of 750cm square per bird along with a nest, perching space at 15cm/bird and a scratching area. In each cage feeding troughs must be at least 12cm/bird and at least two nipple drinkers or two cups must be within easy reach of each hen (where nipple drinkers are provided).

Barn

The barn system has a series of perches and feeders at different levels. The maximum stocking density is 9 birds per square metre and there must be at least 250cm square of litter area/bird. Perches for the birds must be installed to allow 15cm of perch per hen. There must be at least 10cm of feeder/bird and at least one drinker/10 birds. There must be one nest for every 7 birds or 1 square metre of nest space for every 120 birds. Water and feeding troughs are raised so that the food is not scattered.

Free range

In free-range systems the birds are housed as described in the Barn system above. In addition birds must have continuous daytime access to open runs

which are mainly covered with vegetation and with a maximum stocking density of 2,500 birds per hectare.

In all systems the birds must be inspected at least once a day. At the end of each laying period the respective houses are completely cleared and disinfected.

All EU requirements for the above systems can be found in Council Directive 1999/74/EC (http://europa.eu.int/eur-lex/pri/en/oj/dat/1999/l_203/l_20319990803en00530057.pdf), Commission Regulation 2295/2003/EC (http://europa.eu.int/eur-lex/en/consleg/pdf/2003/en_2003R2295_do_001.pdf), as amended by Commission Regulation 1515/2004/EC (http://europa.eu.int/eur-lex/pri/en/oj/dat/2004/l_278/l_27820040827en00070014.pdf) and Welfare of Farmed Animals (England) (Amendment) Regulations 2002 (<http://www.hmso.gov.uk/si/si2002/20021646.htm>)

Organic

Organic systems are similar to those of free range however there are additional guidelines for feed and veterinary requirements. The pullets should be raised by certified organic production methods from birth. There are derogations available if no organic pullets to be found. These derogations are issued under certain conditions and are strictly controlled. Poultry must have access to out doors whenever the weather permits and for at least a third of their life. Where available organic feed must be used although derogations can be obtained for a restricted amount of non-organic feed where it can be demonstrated that no organic feed can be sourced. These derogations are strictly controlled and issued under certain conditions. Organic livestock systems place great emphasis on positive welfare in disease control by using appropriate breeds and development of health building and disease control methods appropriate to the area of the farm. Welfare plans are a national requirement. Medicinal products are only permitted where it is compulsory legislation or where there is a known risk, or

where it is essential to avoid suffering or distress. The use of veterinary medicines is strictly controlled.

The minimum requirements for organic farming in the UK are set out in the "Compendium of UK Organic Standards" which can be accessed on the Defra website at <http://www.defra.gov.uk/farm/organic>.

ANNEX G: BREAKPOINT CONCENTRATIONS FOR ANTIMICROBIAL DRUGS

Antimicrobial	Abbreviation	Concentration (mg/l)
Ampicillin	A	8
Cefotaxime	Ctx	1
Chloramphenicol	C	8
Ciprofloxacin	Cp	0.125; 1
Furazolidone	Fu	8
Nalidixic Acid	Nx	15
Rifampicin	Rf	64
Spectinomycin	Sp	64
Streptomycin	S	16
Sulphonamides	Su	64
Tetracycline	T	8
Trimethoprim	Tm	2

ANNEX H: DEFINITIONS OF CATERING PREMISES AND CUISINE

Definitions of Catering premises

Definitions sourced from Mintel to cover the commercial and retail catering market

Fast food:

- Burger bars
- Pizza restaurants, takeaway and home delivery outlets
- Pasta chains
- Chicken fast food chains
- Fish and chip shops.
- Other types of fast food such as jacket potatoes, sausages, vegetarian specialities, filled croissants.

Pub catering: including food served from the bar and in pub restaurants chains.

Independent and chain restaurants

In-store restaurants Hotel catering: including hotel restaurants, bar and room service.

Other catering including cafes, coffee shops and other retail outlets.

➤ **Other catering types further classified into:**

- **Café:** includes premises selling mainly fried meals and sandwiches and coffee shops.
- **Institutional:** catering facilities serving only customers within a particular building, e.g. hospital and factory canteens.
- **Transportation:** catering facilities on ships, trains and aircraft.
- **Event caterer:** a business that provides catering facilities away from its own base.

Definitions of Cuisine

General / Mixed: Outlets providing a variety of different meal types, e.g. pubs that sell standard fare such as steaks and roasts, but also foods of foreign origin such as chillies, curries and pasta dishes.

Sandwich / Fried: Applies to sandwich bars, coffee shops and bakery shop cafes that sell mainly sandwiches and cakes. Includes those that also provide some fried foods, e.g. English breakfasts.

Grill / Fried: Applies to outlets whose main fare is grilled or fried food, such as burger bars, kebab shops, fish and chip shops, some cafes.

National cuisines: Refers to outlets selling foods from a specified national cuisine, excluding those that fit more appropriately in one of the above categories.

Other specialisms: Outlets that specialise in a particular product or category of food, eg. Vegetarian