LACORS/HPA Co-ordinated Food Liaison Group Studies:

Microbiological Study on Salmonella Contamination of Pooled Raw Shelled Egg Mix and Environmental Samples from Catering Establishments

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On behalf of the Local Authorities Co-ordinators of Regulatory Services (LACORS) and the Health Protection Agency (HPA)

Summary

This study was undertaken in order to investigate the incidence of *Salmonella* contamination in catering premises using pooled raw shelled egg mix (RSEM) as an ingredient in lightly cooked or uncooked foods. The study also evaluated the use of RSEM and hygiene practices. Pooled RSEM, cleaning cloths and surfaces in ready-to-eat food preparation areas were sampled in restaurants, takeaways, bakeries, cafés and sandwich bars between May and October 2008. In total, 934 catering premises were visited in England, Wales, Scotland and Northern Ireland.

Salmonella spp. were detected in 1/764 (0.13%) of egg mixes, 2/726 (0.3%) of environmental swabs and 7/550 (1.3%) of cleaning cloths.

The study showed evidence of poor RSEM storage and handling practices in catering premises:

- 40% failed to use designated utensils when RSEM was added to other ingredients during food preparation;
- 17% did not clean surfaces and utensils thoroughly after they had been used with RSEM and before preparing other foods;
- 43% of staff did not wash and dry hands after handling eggs or RSEM;
- 41% did not store RSEM at refrigeration temperature before use;
- 8% added RSEM to the cooked rice when preparing egg fried rice.

Eighteen percent of caterers did not have a documented food safety management system based on the principles of HACCP in place. This failure was most common in take-away premises and those serving Chinese cuisine.

Awareness of the key food safety points on the use of RSEM was mostly absent from operators of take-away premises (14%), and specifically those serving Chinese cuisine (13%).

All caterers using RSEM need to be aware of the continuing hazards associated with the product and have in place sufficient controls to minimize the risk to human health. Food safety and hygiene training and good practice advice should be utilised by caterers to ensure they have in place effective procedures for the storage, handling and use of RSEM.

Introduction

Eggs continue to be implicated as a source of, or vehicle for cross-contamination, in outbreaks of salmonellosis in the UK, particularly in relation to food prepared in the catering sector. Outbreaks of salmonellosis have been attributed to the use of raw shell eggs and their preparation as pooled mixes, their consumption in uncooked or lightly cooked dishes, and/or as a vehicle for cross-contamination [15,23]. Eggs may occasionally be contaminated with *Salmonella*. The rate of contamination varies according to their country of origin [6,8,23]. The large number of eggs consumed each day means that even a low incidence of *Salmonella* contamination may be significant.

Food poisoning risks associated with food preparation in the catering industry include the use of large volumes of eggs and the practice of pooling and mixing eggs, with which there are numerous risk factors (Figure 1). This practice is particularly common in those premises serving Chinese cuisine [17,27]. One *Salmonella* contaminated egg is capable of contaminating the whole batch of raw shell egg mix (RSEM). Large numbers of consumers may be exposed to this contaminated raw material. The risk is increased if RSEM is stored in a warm kitchen environment, which would allow growth of the pathogen. Cross-contamination may occur during RSEM preparation, particularly when egg mixes are aerosolized during whisking and especially when using an electric whisk. Once on surfaces, salmonellae can survive more than 24 hours in droplets of egg mix or dried batter [2,19]. The transfer of *Salmonella* contaminated RSEM to cleaning materials, such as cloths, is also a cause of concern as these may act as harbourages for the pathogen and transfer in the commercial kitchen [25,26]. Cloths contaminated with *Salmonella* have been associated with outbreaks of infection [18] [S Surman-Lee, HPA, personal communication].

The European Commission Regulation on the hygiene of foodstuffs (Regulation (EC) No. 852/2004) [5] provides a risk-based approach to controlling food hygiene. The Regulation requires businesses to implement a written food safety management system based on hazard analysis and critical control point (HACCP) principles. The Food Standards Agency (FSA) has produced a guide to implementing a food safety management system tailored for small catering businesses and those serving different cuisines [9,10]. This guide, Safer Food Better Business (SFBB), and equivalent guides in Scotland and Northern Ireland (Cook Safe [13], Safe Catering [12]) provide a standardised framework relating to food safety, i.e. the four C's: cooking, prevention of cross-contamination, cleaning, and chilling. The guides are designed to help small businesses comply with the food hygiene regulations and minimise microbial food safety hazards in their food business operations. The SFBB guides for different cuisines (e.g. Chinese cuisines) includes further guidance on the key food safety points on the use of eggs (Figure 1) [9].

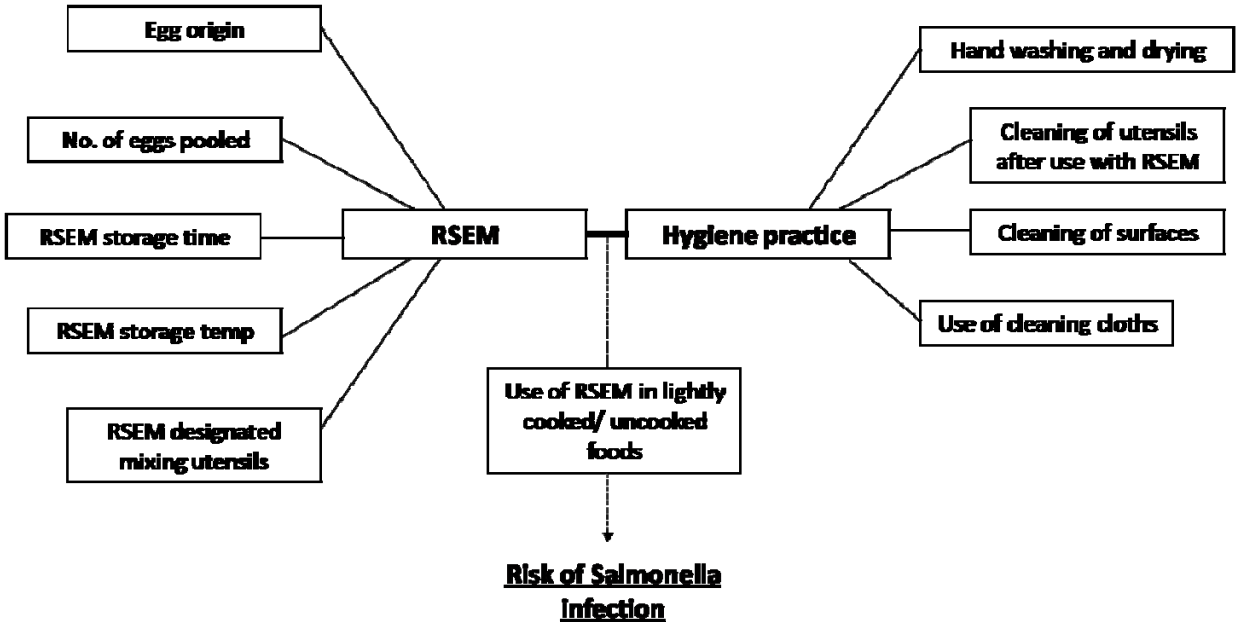

Figure 1. Schematic of risks associated with raw shell egg mix (RSEM) use and hygiene practice in catering establishments.

Those involved in food preparation and service have a vital role in prevention of foodborne disease and their actions can be critical in preventing an outbreak of infection [25]. While surveys have provided useful information regarding *Salmonella* contamination in eggs and highlight the risk associated with direct consumption [4,8,22], information on the incidence of high-risk RSEM practices by caterers that allow growth or survival of *Salmonella* in the RSEM and in the catering environment is needed. The aims of the study were to therefore establish the rate of *Salmonella* contamination of RSEM used by catering premises, investigate the potential for cross-contamination from RSEM within ready-to-eat food preparation areas, and to examine the use of RSEM in catering premises.

Materials and Methods

Collection of samples

Between 1st May and 31st October 2008, 934 catering premises in England, Wales, Scotland and Northern Ireland which used pooled raw shell egg mix (RSEM) were sampled. Suitable premises included any restaurant, take-away, bakery, café, sandwich bar or public house, provided they had pooled RSEM available for sampling. Up to three samples were taken from each premise: one pooled RSEM sample (≥100ml), one environmental swab sample from surfaces where the RSEM was prepared or used, and/or a cleaning cloth used for wiping surfaces in the ready-to-eat food preparation area.

Surfaces were sampled by the surface sponge swab technique using sterile 1.5 x 3 inch foam sampling sponges (SpongeSicle swabs (Sterilab) with 10ml neutralising buffer), in polythene envelopes or plastic containers. Whole cleaning cloths were placed into sterile plastic bags for transport to the laboratory.

Samples were collected and transported to laboratories by sampling officers from 171 Environmental Health Departments (EHDs), involving 46 Local Authority food liaison groups (Annex 1) in accordance with the FSA Food Law Code of Practice [11] and the Local Authorities Co-ordinators of Regulatory Services (LACORS) guidance on microbiological food sampling [24]. These samples were examined by 25 Official Control Laboratories as detailed in Annex 1.

Information on samples and premises was obtained by observation and enquiry, and recorded on a standard questionnaire (Annex 2). Information included the type of catering premises and cuisine served, the presence of a documented food safety management system, and operator awareness on food safety and use of eggs. Sample details included origin and use of raw shell eggs in the RSEM.

Microbiological methods

Samples were prepared as shown in Figure 2, after which the presence of *Salmonella* was sought by selective enrichment and plating, according to the HPA Standard Method F13 [16]. All isolates confirmed as *Salmonella* spp. were sent to the Laboratory of Gastrointestinal Pathogens (LGP), HPA Centre for Infections for further characterisation. This included serotyping [1], phage typing [3] and antimicrobial resistance testing [14].

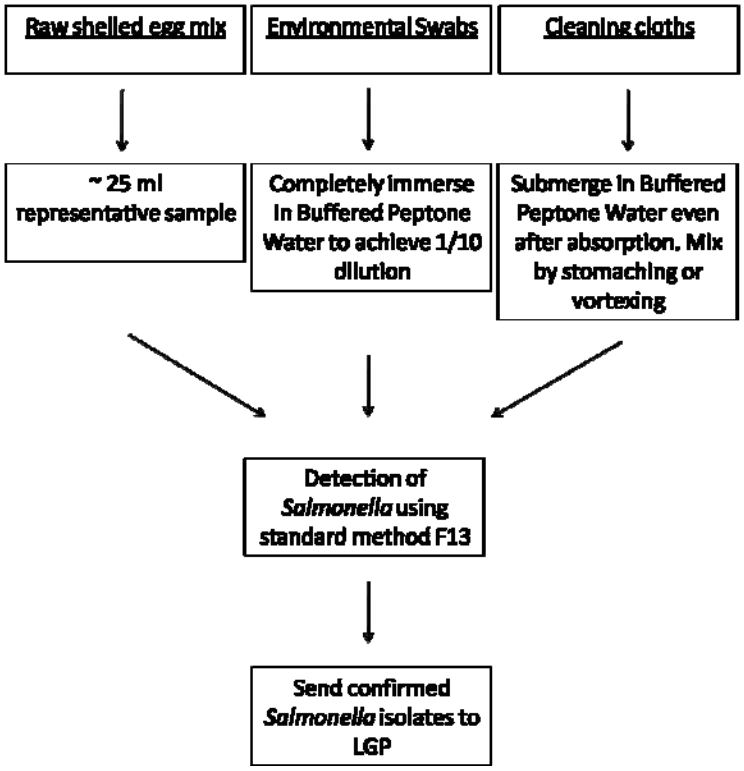

Figure 2. Sample preparation and subsequent steps in the examination of pooled raw shelled egg mix, environmental swabs and cleaning cloth samples.

Data Analysis

Data analysis was performed using Microsoft Excel. Relative proportions were compared using the chi-squared test or Fisher's exact test (http://home.clara.net/sisa/twoby2.htm) and a probability value of less than 0.05 was defined as statistically significant.

Results

In total, 934 catering premises were visited as part of the study. Of these, 489 were take-away premises only (52.4%), 214 were restaurant-takeaways (22.9%) and 145 were restaurants only (15.5%) (Figure 3). The remaining premises comprised of bakeries (31, 3.3%), café/sandwich bars (29, 3.1%) and 'other' premises (26, 2.8% - mainly hotels).

The predominant cuisine type was Chinese (746/934; 79.9%), with British cuisine being the second most common (145/934; 15.5%) (Figure 3).

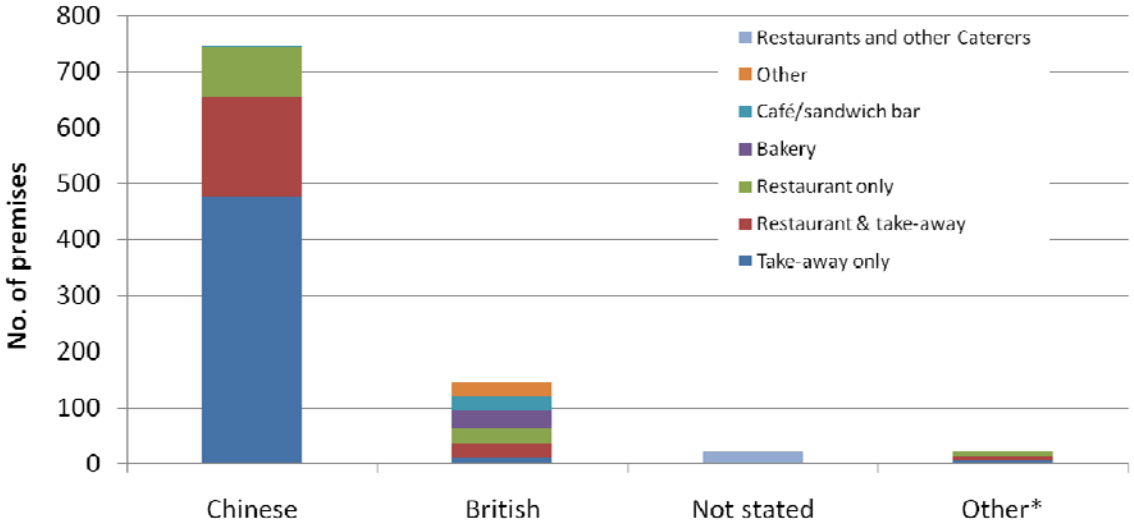

Figure 3. Premises and cuisine type sampled (n=934). * Other cuisines consisted of mixed cuisines mainly, including Thai, Indian/South Asian, Italian, British/Italian and Malaysian/Indonesian.

Salmonella contaminated samples

A low prevalence of *Salmonella* contamination was evident from all sample types collected from premises in this study, with 9 positive samples from 934 (0.96%).

- Out of 764 premises with pooled RSEM available for sampling, one (0.1%) was contaminated with *S*. Enteritidis phage type (PT) 4. This sample was collected from a Chinese takeaway which used shell eggs originating in the UK [*].
- Two environmental swabs taken from surface areas where the RSEM was prepared and/or used (2/726; 0.3%) were positive for *S*. Reading and *S*. Enteritidis PT 4. Again, these swabs were taken from Chinese takeaways which used pooled UK eggs. In addition to the *S*. Reading isolated from an environmental swab, the same serotype was also found in a cleaning cloth used in the same take-away.
- A further six cleaning cloths from different premises (used in ready-to-eat food preparation areas) were also found to be contaminated with *Salmonella*, making 7/550 (1.3%) in total. As seen in table 1, a range of different types of *Salmonella* serotypes was found in the cleaning cloths.

[*] From 934 premises visited, only 764 had RSEM available at the time for sampling. The remaining 170 either did not have any left or available at the time of sampling.

Table 1. *Salmonella* serotypes, phage types (PTs) and antimicrobial resistance profiles isolated from pooled RSEM, environmental swabs and cleaning cloths used in catering premises.

Source of *Salmonella*	***Serotype* and phage type**	**Antimicrobial resistance profile‡**	**Cuisine type**	**Premises type**
Pooled raw shell egg mix	*S.* Enteritidis PT 4	Sensitive	Chinese	Takeaway only
Environmental swab	*S*. Reading	Sensitive	Chinese	Takeaway only
	S. Enteritidis PT 4	Sensitive	Chinese	Takeaway only
Cleaning cloth	*S*. Derby	SSuSpT	British	Bakery
	S. Typhimurium RDNC*	ACSSuSpTTm	Chinese	Takeaway only
	S. Reading	Sensitive	Chinese	Takeaway only
	S. Menhaden	Sensitive	Chinese	Restaurant & take-away
	S. Typhimurium DT† 193	ASSuT	Chinese	Restaurant only
	S. Bredeney	Sensitive	Chinese	Takeaway only
	S. Indiana	Sensitive	Chinese	Restaurant & take-away

*RDNC, Reacts with typing phages, but does not conform to a known type; †DT, definitive type; ‡Key to antimicrobial drugs: A, ampicillin; C, chloramphenicol; S, streptomycin; Sp, spectinomycin; Su, sulphonamides; T, tetracycline; Tm, trimethoprim.

Salmonella was detected in samples collected from a bakery (1/31; 3.2%) (1 cleaning cloth), takeaways (6/489; 1.2%) (1 RSEM, 2 environmental swabs, 3 cleaning cloths), restaurants (1/145; 0.7%) (1 cleaning cloth) and takeaway-restaurants (1/214; 0.5%) (1 cleaning cloth). Although the majority of samples contaminated with *Salmonella* were from premises serving Chinese cuisine (8/746; 1.1%) (Table 1), in proportion this finding was not significantly different to *Salmonella* contaminated samples (1/145; 0.7%) associated with British cuisine premises ($p > 0.05$).

Raw shell egg mix (RSEM) and origin of eggs used

From the 764 premises which had pooled RSEM available for sampling, 597 (78.1%) were prepared from eggs which originated in the UK. The remainder of RSEM samples were made from eggs produced in Germany (41, 5.4%), Spain (35, 4.6%), the Netherlands (22, 2.9%), France (5, 0.7%), Republic of Ireland (1, 0.1%), and eggs of unknown origin (63, 8.2%). Of the 597 RSEM samples prepared from UK eggs, one (0.2%) was found to harbour

Salmonella. Since the majority of pooled RSEMs were made from UK produced eggs, no significant association between *Salmonella* contamination of RSEM and raw shell egg origin, or indeed use of RSEM (described below) was observed ($p > 0.05$).

Use of RSEM and implementation of food safety management systems

It is a legal requirement that a written food safety management system based on HACCP principles is in place in any food premises. Furthermore, food business operators (FBOs) handling eggs in catering premises should be aware of the key food safety points on the use of eggs. A documented food safety management system (FSMS) was maintained in 70.2% (656/934) of catering premises visited, 18.2% (170) did not have a documented FSMS in place and this information was not recorded for 11.6% (108) premises. Sixty-eight percent (639/934) of the operators were aware of the key food safety points on the use of eggs.

Among the categories of catering premises, takeaway only premises were the most likely not to have a written food safety management system in place (129/489; 26.4%) compared to all others (41/445; 9.2%) ($p < 0.0001$). Those premises serving Chinese cuisine (153/746; 20.5%) and 'other' cuisines (10/43; 23.2%) were significantly more likely not to have this system in place compared to premises serving British cuisine (7/145; 4.8%) ($p < 0.0001$). Similarly, significantly more operators in takeaways (only) were not aware of the key food safety points on the use of eggs (68/489; 13.9%) compared to other premises (32/445; 7.1%) ($p < 0.05$). Operators in premises serving Chinese cuisine were significantly less aware of the safe use of eggs (94/746; 12.6%) compared to those serving British (5/145; 3.5%) or other cuisines (1/43; 2.3%) ($p < 0.0001$).

Number of eggs pooled

The numbers of eggs used to prepare pooled RSEM varied from less than 6 to 150 (Table 2), with most using over 24 eggs (292/764; 38.2%). The one RSEM sample from which *Salmonella* was isolated was made using more than 24 eggs, although the exact number of eggs was not recorded. A documented food safety management system was not significantly more likely to be in place in premises using more than 24 eggs in the RSEM than in those premises using less than 24 eggs (75.7% v 66.9%) ($p > 0.05$). Similarly, operator knowledge of egg safety was not significantly more common in premises using more than 24 eggs in RSEMs (70.5%) than in those using less (66.0%) ($p > 0.05$).

Storage of RSEM

Most RSEMs were stored for less than two hours before use (266/764; 34.8%) (Table 2). Of these, 47.4% (126/266) were stored at a temperature of 8°C or lower and 44.0% (117/266) at more than 8°C (range: 8.2°C-27.6°C, mean: 16.7°C) (Figure 4).

The single RSEM sample contaminated with *Salmonella* had been stored for less than two hours at 11.9°C.

Table 2. Egg Safety Practices observed at premises using raw shell egg mix in relation to food safety management systems and food business operator (FBO) knowledge of safe use of eggs.

Egg safety practice	No. (%) of total samples (n = 764)*	Documented food safety management system in place		Operator knowledge of egg food safety	
		Yes (%)	No (%)	Yes (%)	No (%)
Number eggs used in RSEM†					
<6	136 (17.8)	83 (61.0)	25 (18.4)	95 (69.9)	8 (5.9)
6-<12	100 (13.1)	69 (69.0)	20 (20.0)	59 (59.0)	16 (16.0)
12-24	197 (25.8)	139 (70.6)	41 (20.8)	136 (69.0)	27 (13.7)
>24 (range: 25 – 150)	292 (38.2)	221 (75.7)	55 (18.8)	206 (70.5)	36 (12.3)
Not recorded	39 (5.1)	10 (25.6)	6 (15.4)	13 (33.3)	1 (2.6)
Time RSEM stored before use					
< 2 hrs	266 (34.8)	188 (70.7)	47 (17.7)	196 (73.7)	18 (6.8)
2-<4 hrs	143 (18.7)	93 (65.0)	37 (25.9)	87 (60.8)	30 (21.0)
4-6 hrs	95 (12.4)	68 (71.6)	20 (21.1)	68 (71.6)	10 (10.5)
>6 hrs	209 (27.4)	151 (72.2)	36 (17.2)	133 (63.6)	29 (13.9)
Not recorded	51 (6.7)	-	-	-	-
RSEM storage temperature					
≤8°C	408 (53.4)	308 (75.5)	65 (15.9)	298 (73.0)	39 (9.6)
>8°C	312 (40.8)	188 (60.3)	74 (23.7)	179 (57.4)	48 (15.4)
Not recorded	44 (5.8)	26 (59.1)	8 (18.2)	32 (72.7)	1 (2.3)
RSEM mixed by:					
Hand whisk	655 (85.7)	460 (70.2)	127 (19.4)	446 (68.1)	75 (11.5)
Electric whisk	36 (4.7)	24 (66.7)	11 (30.6)	26 (72.2)	7 (19.4)
Not recorded	73(9.5)	-	-	-	-
RSEM used as an ingredient in:					
Lightly cooked food	685 (89.7)	480 (70.1)	137 (20.0)	462 (67.4)	85 (12.4)
Uncooked food	18 (2.4)	23 (74.2)	3 (9.7)	25 (80.6)	1 (3.2)
Not recorded	61 (7.9)	-	-	-	-
Designated utensil used for RSEM					
Yes	372 (48.7)	271 (72.8)	64 (17.2)	265 (71.2)	31 (8.3)
No	306 (40.1)	202 (66.0)	70 (22.9)	200 (65.4)	49 (16.0)
Not recorded	86 (11.2)	-	-	-	-

* The total number of premises where RSEM was able to be sampled; †RSEM=Raw shell egg mix.

Where RSEM was stored for longer the six hours before use, the length of time before it was actually used ranged from seven hours to 144 hours (6 days), with 30.6% (64/209) being stored for 24 hours.

Storage temperatures of RSEM stored for 24 hours were primarily 8°C or lower (151/209; 72.3%), however 54/209 (25.8%) of RSEM were kept at temperatures more than 8°C (range: 8.6°C-26.0°C, mean: 16.1°C). RSEM was significantly more likely to be held at 8°C or lower in premises which stored this ingredient for over six hours compared to those which stored it for less than this time ($p < 0.0001$).

Overall, 53.4% of the RSEM samples were stored at 8°C or lower and 40.8% at more than 8°C (Table 2). The presence of a documented food safety management system was significantly more common in those premises storing RSEM at 8°C or less (75.5%) compared to that stored at more than 8°C (60.3%) ($p < 0.002$).

Operators with an understanding of the safe use of eggs were more likely to store egg mix 8°C or less than at greater than 8°C (73.0% v 57.4%) ($p < 0.05$).

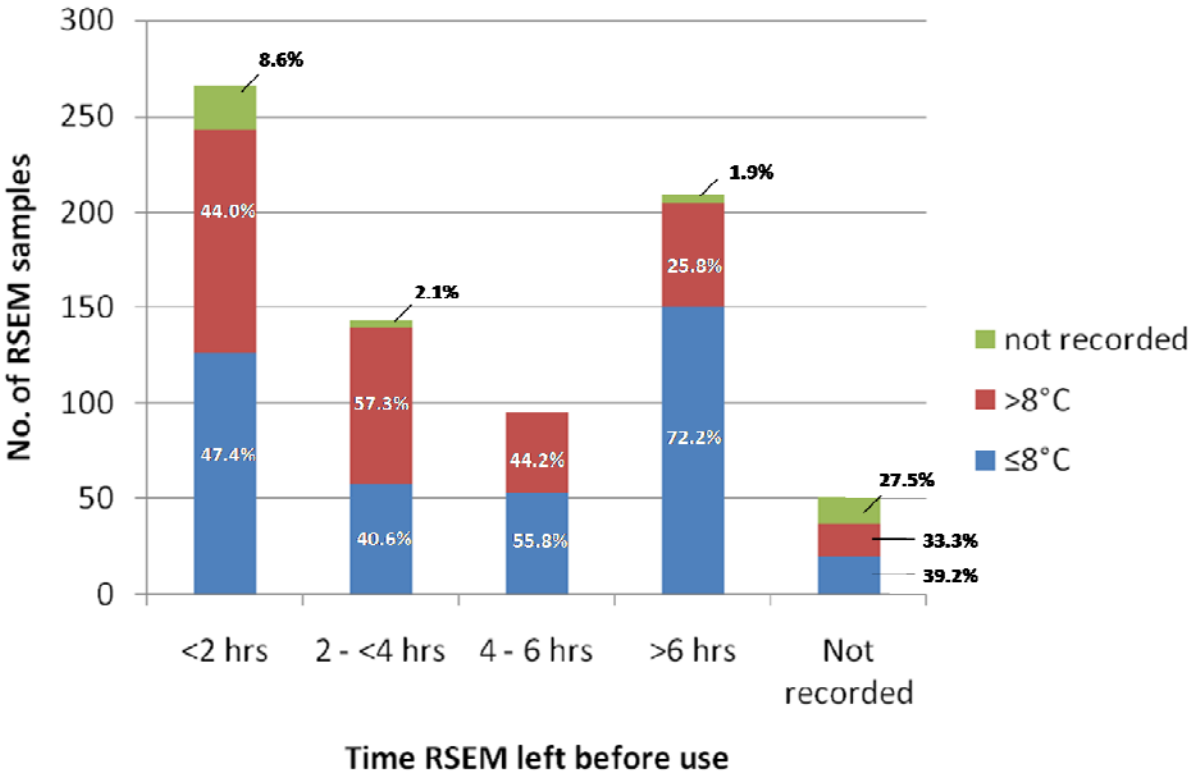

Figure 4. Time and temperature that raw shell egg mixes (RSEM) were stored before use

Use of RSEM in foods and food preparation

Most RSEM samples (655/764, 85.7%) had been prepared using a hand whisk (Table 2). The presence of a documented food safety management system in premises where hand whisks or electric whisks were used was not significantly different (70.2% v 66.7%) ($p > 0.05$). Operators knowledge of egg safety practices did not differ depending on whisking practice (Table 2) ($p > 0.05$).

Ninety percent (685/764) of samples were from RSEM destined for use in lightly cooked food, with only a small proportion (18/764; 2.4%) used in uncooked foods (Table 2). The egg mix sample found to be contaminated with *Salmonella* was to be used as an ingredient in lightly cooked food (egg fried rice).

Of particular risk are RSEM which are left for longer periods of time before being used in lightly cooked or uncooked dishes. Although 34.6% (243/703) of the RSEM to be used in lightly cooked or uncooked foods were left for less than two hours before use, 29.2% (205/703) were left for longer, i.e. more than 6 hours.

Dishes such as egg fried rice are a common lightly cooked food in which RSEM is used. In the current study, where premises made egg fried rice (n=713), 91.8% added the RSEM to the wok first (655/713), but in 8.2% (58) the mix was added after the rice was cooked.

Forty nine percent (372/764) of premises visited with RSEM available used designated utensils for adding RSEM to other ingredients during food preparation, while 40.1% (306/764) did not (Table 2). A greater proportion of premises which allocated a specific utensil for RSEM use had a documented food safety management system in place (72.8%) and operators were aware of the safe use of eggs (71.2%) when compared to those premises that did not use specific utensils for RSEM (66.0%, food safety systems in place ($p < 0.05$); 65.4% operators aware of safe use of eggs ($p < 0.01$).

Hygiene practices

From the 934 premises visited, sampling officers ascertained that staff in 401 (42.9%) of premises did wash and dry their hands after handling eggs or RSEM. However, staff did not wash or dry their hands in 97 (10.4%) premises, and it was not possible to assess this practice in 343 (36.7%).

Of the premises where staff washed and dried their hands after contact with eggs or RSEM, a higher number had in place a documented food safety management system (82.0%) in comparison with those which had staff that did not carry out this practice (60.8%) ($p < 0.001$). Furthermore, in the premises where staff did not wash their hands, knowledge of key food safety points on the use of eggs was significantly less common (54.6%) than at premises where staff did wash and dry their hands (80.3%) ($p < 0.0001$).

Hand washing ability is dictated by whether the premises actually has hand washing facilities in place and available for use. From the 934 premises visited, 795 (85.1%) did have these facilities available for use, but 58 (6.2%) premises did not (Table 3).

Following use with eggs or RSEM and before preparing other foods, kitchen surfaces and utensils were cleaned in 657/934 (70.3%) premises. In these premises, a higher proportion maintained a documented food safety management system (80.2%) compared to those which did not carry out these cleaning practices (69.4%, 111/160) ($p < 0.05$). Operator knowledge on the safe use of eggs was evident in 79.9% of premises where surfaces and utensils were cleaned after used with eggs/RSEM and in 60.0% of premises that did not carry out this practice. In such premises, 28.1% (45/160) of operators did not have knowledge of the safe use of eggs ($p < 0.0001$).

Re-useable cloths were the most commonly used type of cleaning cloth (693/934, 74.2%), with disposable cleaning cloths used in 15.6% (146/934) of premises (Table 3). Forty four percent of premises used separate cleaning cloths for designated food preparation areas and 44.6% did not. The presence of a documented food safety management system

was significantly more common in premises where separate cloths were used for designated areas (82.2%) than in those where they were not (71.5%) ($p < 0.01$). Similarly, operator awareness of food safety relating to the use of eggs was also significantly more common in premises using separate cloths for designated food preparation areas (80.7% v 68.6%) (Table 3) ($p < 0.0001$).

Table 3. Food hygiene practices in catering premises in relation to food safety management systems and operator knowledge of safe use of eggs.

Hygiene Practice	No. (%) of total premises (n = 934)	Documented food safety management system in place		Operator knowledge of egg food safety	
		Yes (%)	No (%)	Yes (%)	No (%)
Do staff wash hands after handling eggs/RSEM					
Yes	401 (42.9)	329 (82.0)	62 (15.5)	322 (80.3)	26 (6.5)
No	97 (10.4)	59 (60.8)	24 (24.7)	53 (54.6)	21 (21.6)
Not possible to assess	343 (36.7)	253 (73.8)	82 (23.9)	252 (73.5)	52 (15.2)
Not recorded	93 (10.0)	15 (16.1)	2 (2.2)	12 (12.9)	1 (1.1)
Washing facilities available:					
Yes	795 (85.1)	617 (77.6)	148 (18.6)	522 (65.7)	30 (3.8)
No	58 (6.2)	35 (60.3)	22 (37.9)	22 (37.9)	8 (13.8)
Not recorded	81 (8.7)	4 (4.9)	0 (0.0)	3 (3.7)	0 (0.0)
Surfaces and utensils cleaned after egg/RSEM use:					
Yes	657 (70.3)	527 (80.2)	112 (17.0)	525 (79.9)	50 (7.6)
No	160 (17.1)	111 (69.4)	41 (25.6)	96 (60.0)	45 (28.1)
Not recorded	117 (12.5)	18 (15.4)	17 (14.5)	18 (15.4)	5 (4.3)
Type of cleaning cloths used:					
Re-useable	693 (74.2)	528 (76.2)	140 (20.2)	510 (73.6)	84 (12.1)
Disposable	146 (15.6)	118 (80.8)	22 (15.1)	116 (79.5)	12 (8.2)
Both	1 (0.1)	0 (0.0)	1 (100)	0 (0)	1 (100)
Not recorded	94 (10.1)	10 (10.6)	7 (7.4)	13 (13.8)	3 (3.2)
Separate cleaning cloths used*					
Yes	409 (43.8)	336 (82.2)	65 (15.9)	330 (80.7)	28 (6.8)
No	417 (44.6)	298 (71.5)	96 (23.0)	286 (68.6)	69 (15.5)
Not recorded	108 (11.6)	22 (20.4)	9 (8.3)	23 (21.3)	3 (2.8)

^ The food safety management system is a written document based on HACCP principles.

* Separate cleaning cloths used for designated food preparation areas.

Discussion

This study focussed on hygiene practices and risks related to the pooling and mixing of raw shell eggs which would be subsequently used in lightly cooked or uncooked foods in catering premises. Overall, 1/764 (0.1%) of raw shell egg mix (RSEM) was found to be contaminated with *Salmonella*, which was confirmed as *S*. Enteritidis phage type (PT) 4. This phage type is associated with *Salmonella* infection as a result of egg consumption or dishes made from eggs [15].

The egg supply chain to the UK catering market differs from that of the retail market; caterers receive most of their eggs from non-UK sources. However, the volume of eggs imported to the UK fluctuates throughout the year and closely reflects supply and demand. Interestingly, in this study 78% of RSEM samples were known to have been made from UK eggs and only 14% from non–UK origin. However, the nature of the UK catering egg market may allow the sporadic introduction of highly contaminated eggs [23]. Previous surveys have shown non-UK eggs have, in the past, a higher rate of *Salmonella* contamination compared with eggs produced in the UK [8,23]. A survey of UK eggs on retail sale in 2003 showed that 0.3% were contaminated with *Salmonella* [8]. By comparison, a survey of non-UK eggs on retail sale in the UK in 2005/2006 found that 9.0% were contaminated with *Salmonella* [23]. *Salmonella* in contaminated eggs or RSEM can survive certain cooking methods [20], and eggs and dishes made from RSEM should always be cooked in line with the Food Standards Agency's (FSA) advice [7]. Caterers should continue to increase their use of pasteurised eggs, particularly for dishes that are not subject to further cooking prior to consumption.

Cross-contamination during the preparation of RSEM is a fundamental problem in the catering kitchen and can lead not only to the contamination of other foodstuffs, but also the surrounding environment, turning surfaces and utensils into potential harbourages for *Salmonella*. Humphrey *et al*. (1994) have shown that a direct relationship exists between levels of *Salmonella* contamination of RSEM and the production of contaminated aerosols and contamination of hands or kitchen utensils. They also showed that *Salmonella* can be recovered some distance away from the RSEM mixing bowl and that this pathogen can persist for prolonged periods (up to 24 hours) on work surfaces [21]. In this study, 0.3% of ready-to-eat food preparation surfaces and 1.3% of cleaning cloths used in areas where the RSEM was prepared were found to be contaminated with *Salmonella*. Other studies have also shown the cleaning cloth to be an important vehicle for the transfer of bacteria in commercial kitchens [25,26]. Of particular concern in the current study was that 45% of catering premises did not use separate cleaning cloths for designated food preparation areas. It is therefore important that effective cleaning schedules are established, along with separation of cleaning equipment used to clean ready-to-eat and non-ready-to-eat food preparation areas.

Those involved in food preparation and service have a vital role in prevention of foodborne disease and their actions can be critical in preventing an outbreak of infection [25]. Food safety concerns identified in relation to use of RSEM in catering premises included:

- the failure to use designated utensils with RSEM when adding to other ingredients during food preparation (40%);
- not cleaning surfaces and utensils thoroughly after they had been used with RSEM and before preparing other foods (17%);

- staff not washing and drying hands after handling eggs or RSEM (43%) even though most premises had hand washing facilities;
- not storing RSEM at refrigeration temperature before use (41%) and particularly when prepared well in advance before use (i.e. 6 – 24 hours) (26%);
- adding RSEM to the cooked rice when preparing egg fried rice (8%).

Reducing the food safety risks associated with RSEM use is a multi-factorial process, combining appropriate storage temperatures (RSEM should be stored below 8°C), minimising storage times, safe use in other foods and good hygiene practices. Evidence on poor egg or RSEM storage and handling practices in catering premises from the present survey concurs with that previously reported in the United Kingdom [4,22]. Poor practice in the use of RSEM presents an unacceptable level of risk to the consumer.

The importance of the proper use of RSEM and effective cleaning of food surfaces for reducing the potential of cross-contamination is well recognised and is an important component of food safety management systems. Nevertheless, a fifth of caterers in this study did not have a documented food safety management system based on the principles of HACCP in place [5]. This failure was most common in take-away premises (only) and those serving Chinese cuisine. Furthermore, awareness of the key food safety points on the use of RSEM [10] was more likely to be absent from operators of take-away premises and again those serving Chinese cuisine. This may reflect the transient nature and high staff turnover of some of these types of businesses. Clearly the FSA's food safety guidance is not being adhered to [7,9,10].

These findings are of particular interest due to the recent decrease of *Salmonella* outbreaks linked to eggs and egg dishes [23], however high risk practices associated with eggs in the catering industry continue to be observed and these must be addressed to reduce the risk of *Salmonella* infections.

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Annex 1. Participating Official Control Laboratories and Local Authority Food Liaison Groups and number of samples.

Table I. Participating food liaison groups and number of samples.

Food Liaison Group	Number of samples
Berkshire	10
Buckinghamshire	17
Cheshire	38
Cornwall	19
Cumbria	18
Derbyshire	10
Devon	30
Dorset	12
Durham	4
East Sussex	5
Essex	9
Gloucestershire	3
Greater Manchester	39
Hampshire & Isle of Wight	60
Hereford & Worcester	25
Hertfordshire & Bedfordshire	86
Humberside/North Lincoln	26
Kent	13
Lancashire	19
Leicestershire	5
LFCG[1] NE Sector	10
LFCG NW Sector	3
LFCG SE Sector	2
Lincolnshire	2
SFELG[2]	23
Merseyside	16
North Wales	3
North Yorkshire	6
Northamptonshire	7
Northern Ireland Food Group[3]	144
Nottinghamshire	34
Oxfordshire	17
Somerset	13
South/West Yorkshire	33
Staffordshire	9
Suffolk	4
Surrey	12
Sussex	7
Tees Valley	33
Tyne & Wear	27
Warwickshire	31
West Midlands	28
West of England	22
Total	934

[1] LFCG, London food coordinating group; [2] SFELG, Scottish Food Enforcement Liaison Group consisting of North Scotland, West of Scotland and Lothian and Scottish Borders; [3] Northern Ireland Food Group consists of Northern Ireland and Northern Ireland Southern.

Table II. Participating HPA, HPA Collaborating Laboratories and other Official Control Laboratories and number of samples.

Region	Laboratory Name	Number of samples
East	Chelmsford	13
East Midlands	Leicester	5
	Lincoln	37
London	London	118
North East	Newcastle	64
North West	Carlisle	17
	Chester	55
	Preston	61
South East	Ashford	13
	Haywards Heath	22
	Plymouth	2
	WEMS*	82
South West	Bristol	25
	Exeter	15
	Plymouth	26
	Truro	19
	WEMS	17
West Midlands	Birmingham	75
	Hereford	16
	Stoke	9
Yorkshire and Humberside	Leeds	57
	Sheffield	19
Northern Ireland	Belfast	144
Scotland	Public Analyst - Glasgow	10
	Public Analyst - Aberdeen	6
	Public Analyst - Edinburgh	6
	Public Health Laboratory - Aberdeen	1
Total		934

*WEMS= Wessex Environmental Microbiology Services, Southampton.

Annex 2. LACORS/HPA coordinated food liaison group study questionnaire.

LABORATORY NAME..... Laboratory Sample Numbers: Egg Mix..... Swab..... Cloth.....

Annex 4 for Study 34 (LLACORS002) LACORS/HPA CO-ORDINATED FOOD LIASION GROUP STUDY: QUESTIONNAIRE

Microbiological Study on *Salmonella* Contamination of Pooled Raw Shelled Egg Mix & Environmental Samples from Catering Establishments: 1 May – 31 Oct 08

All information must be correctly and clearly entered on the form using black ink to facilitate clear photocopying

1. Local Authority..... 2. Food Liaison group .....

3. Samplers Name... .....& contact number: ..... 4. Sample collected at..... (time) on (date) ...../...../.....

5. LA Premises Reference Number..... 6. LA Sample Reference Numbers: Raw egg mix..... Swab..... Cloth.....

Premises details:

7. Name of premises.....

8. Address..... Postcode.....

9. Type of premises:	Restaurant only ☐ Take-away only ☐ Restaurant & take-away ☐ Bakery ☐ Public house ☐ Café/sandwich bar ☐ Other ☐ (Specify).....
10. Type of cuisine (where available):	Chinese ☐ Indian/South Asian ☐ Thai ☐ Malaysian/ Indonesian ☐ British ☐ Italian ☐ Spanish ☐ French ☐ Middle Eastern (eg Turkish, Moroccan) ☐ Other ☐ (Specify).....

Pooled Raw Shelled Egg Mix (RSEM) Sample Details: *Sample must be a minimum of 100 mls*

11. Of the eggs used to make the RSEM, specify country of origin.....& stamp marking on the shells (e.g. 0UK12345).....

12. How many eggs were pooled in the RSEM? <6 ☐ 6 - <12 ☐ 12 - 24 ☐ >24 ☐(Specify).....

13. How long is the RSEM left before use: <2 hrs ☐ 2 – <4hrs ☐ 4 - 6 hrs ☐ >6hrs ☐(Specify).....

14. Is the RSEM stored at: Equal/below 8°C ☐ & specify temperature.....°C
or Above 8°C ☐ & specify temperature.....°C

15. Is the RSEM mixed using a: Hand whisk ☐ OR Electric whisk ☐

16. Is the RSEM, *used as an ingredient* in : Lightly cooked foods YES ☐ e.g. egg fried rice & Go to Q17, omelettes, desserts, etc.
NO ☐ & Go to Q18
Uncooked foods YES ☐ e.g. desserts, icing, sauces, salad dressings, etc.
NO ☐ & Go to Q18

17. In making egg fried rice, is the RSEM added to the wok: First ☐ OR to Cooked rice ☐

18. Is a designated utensil (e.g. ladle) used with RSEM when adding to other ingredients during food preparation? YES ☐ NO ☐

Hygiene practices:

Please indicate hygiene sample(s) collected (tick all that apply):
Cleaning cloth ☐ Environmental swab from worktop surface by/near where eggs are pooled & mixed ☐
OR Environmental swab from surface area where the RSEM is used ☐

19. Is a written food safety management system (SFBB, CookSafe, SafeCatering) based on HACCP principles maintained? YES ☐ NO ☐
& is the operator aware of the key food safety points on the use of eggs? YES ☐ NO ☐

20. Do staff wash & dry their hands after handling eggs and/or RSEM? YES ☐ NO ☐ or NOT possible to assess at the time of the visit ☐

21. On the day of sampling, were hand washing facilities available & accessible for use? YES ☐ NO ☐

22. Are surfaces and utensils cleaned after use with eggs/RSEM and before preparing other foods: YES ☐ NO ☐

23. Are cleaning cloths used: Disposable ☐ OR Re-useable ☐

24. Are separate cleaning cloths used for designated food preparation areas? YES ☐ NO ☐

COPY TO: Laboratories to retain a copy of the questionnaire for the purposes of validating data within the Excel Workbook

Page 1 of 2

Laboratory details:

Sample(s) received in laboratory……. (time) on (date) ……/. ….../……..
Sample(s) received by……
Sample(s) received from……
Temperature on receipt……°C
Within the cool box is a temperature monitoring device used e.g. data logger : YES ☐ NO ☐
Sample(s) examined. …… (time) on (date) ……/……/ ……

MICROBIOLOGICAL RESULTS

1. **Pooled Raw Shelled Egg Mix Sample**

   Laboratory Sample No……

   Salmonella spp. Detected / 25ml ☐ *Salmonella* spp. Not Detected / 25ml ☐

2. **Worktop / Area Surface Swab Sample**

   Laboratory Sample No……

   Salmonella spp. Detected /Swab ☐ *Salmonella* spp. Not Detected /Swab ☐

3. **Cleaning Cloth Sample**

   Laboratory Sample No……

   Salmonella spp. Detected / Cloth ☐ *Salmonella* spp. Not Detected / Cloth ☐

Date *Salmonella* isolates sent to the Laboratory of Enteric Pathogens, HPA Centre for Infections or in Scotland to the Scottish Reference Laboratory (Stobhill Hospital Glasgow) ……

For the purpose of this study, isolates sent to LEP or Stobhill must be clearly labelled 'LLACORS002', and have the type of sample, laboratory reference sample number, and the name of the referring laboratory on each culture.

MICROBIOLOGISTS COMMENTS……
……
……

Signature …… Date reported ……

Methods as defined in LACORS/HPA Salmonella Contamination of Egg Mix & Environmental Samples from Restaurants & Take-aways (Study 34/LLACORS002); Annex 5

COPY TO: Laboratories to retain a copy of the questionnaire for the purposes of validating data within the Excel Workbook