**ACM/913**

**ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD**

**INFORMATION PAPER**

# Microbiological Examination of Dried Spices and Herbs from Production and Retail Premises in the United Kingdom

The final report of this study carried out in 2004 is attached for Members' information.

**Secretariat**
**June 2008**

# Microbiological Examination of Dried Spices and Herbs from Production and Retail Premises in the United Kingdom

**SK Sagoo[1*], CL Little[1], M Greenwood[2], V Mithani[1], J McLauchlin, E de Pinna, J Threlfall and the Food, Water and Environmental Surveillance Network[†].**

**1 Department of Gastrointestinal Infections, Centre for Infections, Health Protection Agency, 61 Colindale Avenue, London NW9 5EQ**.

**2 Health Protection Agency Wessex Environmental Microbiological Services, Southampton General Hospital, Southampton, UK**

*, Corresponding author, †, FWES Network comprises Laboratories listed in Annex 1

**On behalf of the Food standards Agency, Local Authorities Co-ordinators of Regulatory Services and the Health Protection Agency**

## Summary

As part of the European Commission co-ordinated programme for the official control of foodstuffs, a study of dried spices and herbs from retail and production premises was undertaken in the UK during 2004 to determine the microbiological status of these products. According to microbiological criteria in Recommendation 2004/24/EC and European Spice Association specifications, 96% of 2833 retail samples and 92% of 132 production batches were of satisfactory/acceptable quality. *Salmonella* spp. was detected in both 1% of dried spices and herbs sampled at retail and production. Overall, a small proportion of herbs and spices contained high counts of *B. cereus* (1%, $\geq 10^4$ cfu/g), *C. perfringens* (0.4%, $\geq 10^3$ cfu/g) and *E. coli* (2.1%, $\geq 10^2$ cfu/g). Ninety percent of samples examined were recorded as being 'ready-to-use'. The potential public health risk of using spices and herbs as an addition to ready-to-eat foods that potentially undergo no further processing is therefore highlighted in this study. Prevention of microbial contamination in dried herbs and spices lies in the application of good hygiene practices during growing, harvesting and processing from farm to fork, and effective decontamination. In addition, the importance of correct food handling practices and usage of herbs and spices by end users cannot be overemphasised.

## Introduction

Spices and herbs are valued for their distinctive flavours, colours and aromas and are among the most versatile and widely used ingredient in food preparation and processing throughout the world. Spices are generally grown in the tropical and sub tropical regions, whereas herbs are grown in the more temperate parts of the world. As with many other agricultural products, spices and herbs may be exposed to a wide range of microbial contamination during pre- and post-harvest, including processing, storage, distribution, sale and/or use[1-3]. For example, the traditional method of drying spices and herbs post harvest is to spread them out on the ground to dry under the sun; however this potentially exposes them to the risk of contamination. The use of enclosed drying systems can reduce this problem considerably.

Dried spices and herbs may therefore contain high levels of microbial contamination, depending on whether they have received a form of treatment or not[3,4]. Bacteria of public health importance, such as *Salmonella,* may be present and this could potentially create a public health risk depending on the end use, such as addition to ready-to-eat foods that undergo no further processing. Some outbreaks of salmonellosis have been linked to the consumption of foods seasoned with black or white pepper[5,6], chilli, turmeric powder[7], paprika powder flavoured potato chips[8], and aniseed containing tea[9]. *Bacillus cereus* may also be present in spices and herbs, usually at counts below $10^3$ cfu/g but may multiply to high levels ($10^5$ – $10^6$ cfu/g) in food to which it is added; this may be sufficient to cause food poisoning if the food is inappropriately handled or stored[4,6-7].

The control of microbial contamination in these products lies in the application of good hygiene practices in the production/harvesting area, processing, and personnel. In addition to good hygienic practices, many spice and herb suppliers apply control processes based on steam or dry heat treatments. These processes are designed to minimise the risk from pathogens and to retain the natural characteristics of the products. Codex has produced a Code of Hygienic Practice for Spices and Dried Aromatic Plants[10] for spice and herb

growers/suppliers to help minimize microbial food safety hazards. There are no microbiological standards for dried spices and herbs in EC legislation, however the Codex Code of Hygienic Practice[10] specifies that dried spices and herbs should be free from pathogenic microorganisms at levels that may represent a hazard to health and further requires that *Salmonella* should be absent in treated ready-to-eat spices. The European Spice Association (ESA) also specifies that *Salmonella* should be absent in 25g of spice, *Escherichia coli* to be present at less than $10^2$ cfu/g, and other bacteria requirements to be agreed between buyer and seller[11,12]. To gain insight on the prevalence of *Salmonella,* and the frequency and levels of *Bacillus cereus, Clostridium perfringens* and *E. coli* contamination in these spice and herb products from production and retail premises, the European Commission Recommendation 2004/24/EC required Member States to carry out a co-ordinated programme of sampling and testing of dried spices and herbs[13]. Reported here is a detailed analysis of the UK contribution to the 2004 EC co-ordinated food sampling programme.

## Materials and Methods

### Sample collection

Dried spices and herbs collected from retail and production premises were examined by 38 Official Food Control laboratories (Health Protection Agency (HPA), HPA Collaborating Laboratories, National Public Health Service (NPHS)-Wales and Public Analysts) in the UK between 1 July and 31 December 2004 according to a standardised protocol. Five sample units (5 x ≥30g) were collected from each batch at production premises using class attribute sampling plans as provided in Commission Recommendation 2004/24/EEC[13]. At retail premises single samples (≥30g) were collected. Samples were collected and transported to laboratories by staff from 293 local Environmental Health Departments, involving 271 Local Authority Food Liaison Groups (Annex 2), in accordance with the FSA Food Law Code of Practice[14] and LACORS guidance on microbiological food sampling[15].

Information on samples and premises was obtained by observation and enquiry and recorded on a standard proforma. Additional information collected included the type of spice or herb, country of origin, packing details, processing and treatment details, existence of a hazard analysis system and the level of food hygiene training received by the manager. Food hygiene inspections are carried out in a way that focuses enforcement authority resources on premises presenting most risk to consumers. To do this, food hygiene inspections are carried out in accordance with FSA Food Law Code of Practice[14] which specifies that, amongst other factors, the number of consumers at risk and confidence in management control systems (including the application of HACCP based systems) should be assessed to produce a risk rating of the premises. The risk rating determines the frequency of inspection and at the time of this study ranged from Category A (highest risk, inspected every 6 months) to F (lowest risk, inspected every 5 years).

**Sample examination**

*Salmonella* spp., *E. coli*, Enterobacteriaceae, *B. cereus* and other *Bacillus* spp. and *C. perfringens* were detected or enumerated in accordance with HPA Standard Microbiological Methods[16-20]. Isolates of *Salmonella* spp. were sent to the Laboratory of Enteric Pathogens (LEP), Health Protection Agency Centre for infection (HPA CfI), for typing and further characterisation. Isolates of *B. cereus* and other *Bacillus* spp. at ≠$10^5$ cfu/g were sent to the Food Safety Microbiology Laboratory (FSML) HPA CfI for further confirmation.

The microbiological status of dried herb and spice samples were assessed using criteria in Recommendations 2004/24/EC[13] and the European Spice Association (ESA) specifications[12] (Tables 1 and 2).

**Table 1: Classification of dried herbs and spices from production premises as recommended by microbiological criteria within Recommendation 2004/24/EC[13] and ESA[12]**

| Microorganism | Microbiological quality* |
|---|---|
| *Bacillus cereus* | n=5, c=1, m= $10^3$ cfu/g, M =$10^4$ cfu/g |
| *Clostridium perfringens* | n=5, c=1, m= $10^2$ cfu/g, M =$10^3$ cfu/g |
| *Salmonella* spp. | n = 5, c = 0, Absent in 25 g |
| *Escherichia coli* | n = 5, c=1, m= 10 cfu/g, M = $10^2$ cfu/g |

*Parameters defined as follows:

n = number of units comprising the sample
m = limit below which all results are considered satisfactory
M = limit above which all results are considered unsatisfactory
c = number of sample units that may fall between m and M

For *B. cereus* and *C. Perfringens* the status of a batch is considered to be:

- Satisfactory where all the values are m or less
- Acceptable where the maximum of c values are between m and M
- Unsatisfactory if one or more values is/are equal or above M or more than c values between m and M

For *Salmonella* spp. the status of a batch is considered to be:

- Satisfactory where all the values are not detected in 25g
- Unsatisfactory where one or more values are detected in 25g

**Table 2: Classification of dried herbs and spices from retail premises as recommended by microbiological criteria within Recommendation 2004/24/EC[13] and ESA[12]**

| | Microbiological quality (cfu per gram unless stated) | | |
|---|---|---|---|
| **Microorganism** | **Satisfactory** | **Acceptable** | **Unsatisfactory** |
| *Bacillus cereus* | <$10^3$ | $10^3$ -<$10^4$ | ≥$10^4$ |
| *Clostridium perfringens* | <$10^2$ | $10^2$ -<$10^3$ | ≥$10^3$ |
| *Salmonella* spp. | *ND in 25g | – | Detected in 25g |
| *Escherichia coli* | <10 | 10-<$10^2$ | ≥$10^2$ |

*ND = not detected in 25g

For the purposes of the EC co-ordinated sampling programme, the Enterobacteriaceae count was used as an indicator for possible irradiation or other treatments of spices and herbs (Recommendation 2004/24/EC)[13]. Samples that had an Enterobacteriaceae count of ≤100 cfu/g were therefore considered as having been irradiated or submitted to heat treatments[13].

### Statistical Analysis

Descriptive and statistical analysis of the data was undertaken using Microsoft Excel and Epi Info version 6.04d. Relative proportions were compared using the chi-squared ($\chi^2$) and Fisher's exact tests. A probability value of less than 5% was deemed to be significant.

## Results

### Microbiological status of dried spices and herbs

In total 132 (660 sample units) batches and 2833 samples of dried spices and herbs were tested from production and retail establishments, respectively. Of these, 2199 (74%) were spices (*Capsicum* spp., *Piper* spp. and other types) and 766 (26%) were herbs.

#### *Production Establishments*

Applying the criteria in Recommendation 2004/12/EC and ESA specifications (Table 1), 75% (98/132) of the batches of dried herbs and spices were of satisfactory microbiological quality, 17% (23) were of acceptable quality, and a further 8% (11) were of unsatisfactory quality due to the presence of *Salmonella* spp., *E. coli* (ranging from 2.4 $x10^3$ – 1.0 $x10^7$ cfu/g) and/or high levels of *B. cereus* (ranging from 1.0 x $10^5$ – 2.3 $x10^7$ cfu/g) (Table 3).

**Table 3. Microbiological status of dried spices and herbs according to Recommendation 2004/24/EC[13] and ESA[12] specifications from production premises in the UK**

| Microorganism | Product Identification | Number of samples | Analysis results | | |
|---|---|---|---|---|---|
| | | | Satisfactory | Acceptable | Unsatisfactory |
| *Salmonella* spp. | *Capsicum* spp. | 18 | 18 | 0 | 0 |
| | *Piper* spp. | 28 | 28 | 0 | 0 |
| | Other spices | 63 | 61 | 0 | 2 |
| | Herbs | 23 | 23 | 0 | 0 |
| *Bacillus cereus* | *Capsicum* spp. | 18 | 16 | 2 | 0 |
| | *Piper* spp. | 28 | 22 | 4 | 2 |
| | Other spices | 63 | 54 | 6 | 3 |
| | Herbs | 23 | 16 | 5 | 2 |
| *Clostridium perfringens* | *Capsicum* spp. | 18 | 17 | 1 | 0 |
| | *Piper* spp. | 28 | 27 | 1 | 0 |
| | Other spices | 63 | 61 | 2 | 0 |
| | Herbs | 23 | 22 | 1 | 0 |
| *Escherichia coli* | *Capsicum* spp. | 18 | 15 | 2 | 1 |
| | *Piper* spp. | 28 | 27 | 1 | 0 |
| | Other spices | 63 | 62 | 1 | 0 |
| | Herbs | 23 | 22 | 0 | 1 |
| Enterobacteriaceae | | Analysis results | | | |
| | | | £100 cfu/g | | >100 cfu/g |
| | *Capsicum* spp. | 18 | 7 | | 11 |
| | *Piper* spp. | 28 | 19 | | 9 |
| | Other spices | 63 | 25 | | 38 |
| | Herbs | 23 | 8 | | 15 |

### *Retail Premises*

Applying the criteria in Recommendation 2004/12/EC[13] and ESA specifications[12] (Table 2), 85% (2415/2833) of the dried herbs and spices samples were of satisfactory microbiological quality and 11% (307) were of acceptable quality. A further 4% (111) were of unsatisfactory quality due to the presence of *Salmonella* spp., and/or high levels of *E. coli* (ranging from $1.0 \times 10^3$ - ǂ$10^7$ cfu/g), *C. perfringens* (ranging from $1.0 \times 10^3 – 2.4 \times 10^5$ cfu/g) and *B. cereus* (ranging from $1.7 \times 10^5 – 1.2 \times 10^6$ cfu/g) (Table 4).

**Table 4. Microbiological status of dried spices and herbs according to Recommendation 2004/24/EC[13] and ESA[12] specifications from retail premises in the UK**

| Microorganism | Product Identification | Number of samples | Analysis results | | |
|---|---|---|---|---|---|
| | | | Satisfactory | Acceptable | Unsatisfactory |
| *Salmonella* spp. | *Capsicum* spp. | 534 | 528 | 0 | 6 |
| | *Piper* spp. | 327 | 323 | 0 | 4 |
| | Other spice | 1229 | 1218 | 0 | 11 |
| | Herbs | 743 | 733 | 0 | 10[£] |
| *Bacillus cereus* | *Capsicum* spp. | 534 | 512 | 15 | 7 |
| | *Piper* spp. | 327 | 299 | 25 | 3 |
| | Other Spices | 1229 | 1101 | 120 | 8[¥] |
| | Herbs | 743 | 685 | 56 | 2 |
| *Clostridium perfringens* | *Capsicum* spp. | 534 | 512 | 22 | 0 |
| | *Piper* spp. | 327 | 324 | 2 | 1 |
| | Other spices | 1229 | 1200 | 25 | 4[£¥] |
| | Herbs | 743 | 696 | 42 | 5 |
| *Escherichia coli* | *Capsicum* spp. | 534 | 520 | 12 | 2 |
| | *Piper* spp. | 327 | 316 | 6 | 5 |
| | Other spices | 1229 | 1188 | 28 | 13 |
| | Herbs | 743 | 664 | 40 | 39 |
| Enterobacteriaceae | | Analysis results | | | |
| | | | £100 cfu/g | | >100 cfu/g |
| | *Capsicum* spp. | 534 | 295 | | 239 |
| | *Piper* spp. | 327 | 199 | | 128 |
| | Other spices | 1229 | 803 | | 425 |
| | Herbs | 743 | 275 | | 469 |

£ One sample detected with *Salmonella* spp. also had unsatisfactory levels of *C. perfringens*
¥ One sample had unsatisfactory levels of both *B. cereus* and *C. perfringens*

### Salmonella *spp. present in dried herbs and spices*

*Salmonella* spp. was detected in 1% (2/132) of production batches and 1% (31/2833) of samples collected from retail establishments. Details of the *Salmonella* serotypes recovered from the dried spices and herbs are provided in Table 5. Seventeen different *Salmonella* serotypes were obtained from 16 different types of dried herbs and spices. Twenty percent (6/30) of the referred isolates were identified as *S*. Senftenberg.

**Table 5. *Salmonella* spp. isolates from dried spices and herbs**

| Type of Sample | Number of Batches/ Samples | *Salmonella* sero /phage types (resistance to antimicrobial drugs*) |
|---|---|---|
| ***Dried Spices:*** | | |
| Cumin | 3 | *S*. Carcass (SuTTm)<br>*S*. Montevideo<br>*Salmonella* spp.¤ |
| Fennel | 1 | *S*. Edinburgh |
| Garam masala | 1 | *S*. Clifton |
| Chilli | 3 | *S*. Typhimurium RDNC†<br>*S*. Senftenberg<br>*S*. Aequartoria |
| Black pepper | 5 | *S*. Senftenberg<br>*S*. Poona<br>*S*. Infantis<br>*S*. Schwarezengrund<br>*S*. Saint- Paul |
| Turmeric | 4 | *S*. Senftenberg (2)<br>*S*. Friedenau<br>*S*. Tennessee |
| Cayenne | 2 | *S*. Hvittingfoss<br>*Salmonella* spp.¤ |
| All spice | 1 | *S*. Senftenberg |
| Cinnamon | 1 | *S*. Senftenberg |
| Curry | 1 | *S*. Montevideo |
| Okra | 1 | *S*. Hato |
| ***Dried Herbs:*** | | |
| Coriander | 6 | *S*. Derby<br>*S*. Montevideo (ACr)<br>*S*. Infantis (SSuSpTFu)<br>*S*. Agona (2),<br>*S*. Typhimurium RDNC† |
| Fenugreek | 1 | *S*. Mbandaka |
| Oregano | 1 | *Salmonella* spp.¤ |
| Mint | 1 | *S*. Typhimurium DT‡ 193 |
| Sage | 1 | *S*. Agona |

* Key to antimicrobial drugs: A, Ampillicin; C, Ciprofloxacin; Cr Cephradine, Fu, Fulphonamide S, Steptomycine; Su, Sulphonamides; T, Tetracycline; Tm, Trimethoprim

¤ Isolates not referred for further typing

† Reacted with the phage set but did not confirm to a recognised phage type

‡ DT, definitive phage type

## *Bacillus* spp. and *B. cereus* isolated at ≥ $10^5$ cfu/g from dried spices and herbs

Of the 294 *Bacillus* spp. and *B. cereus* isolates at ≥ $10^5$ cfu/g (obtained from 227 samples; ranged from 1.0 x $10^5$ – 6.9 x $10^9$ cfu/g) referred for characterisation, most were (58%; 169/294) shown to be *B. subtilis,* and the remainder to be *B. pumilus, B. cereus* and *B. licheniformis*. (Table 6). Annex 1 provides further details about the types of *Bacillus* spp. isolated from specific spice or herb types.

**Table 6. *B. cereus* and other *Bacillus* spp. isolated at ≥ $10^5$ cfu/g from dried spices and herbs**

| Dried spices | Number of Isolates* |
|---|---|
| *B. amyloliquefaciens* | 1 |
| *B. cereus* | 37 |
| *B. licheniformis* | 32 |
| *B. pumilus* | 45 |
| *B. subtilis* | 166 |
| **Dried herbs** | |
| *B. cereus* | 8 |
| *B. licheniformis* | 1 |
| *B. pumilus* | 1 |
| *B. subtilis* | 3 |

* 67 samples had more than one type of *Bacillus spp*. present.

**Enterobacteriaceae *at £100cfu/g present in dried herbs and spices***

Forty five percent (59/132) of production batches and 56% (1572/2833) of retail spice and herb samples had Enterobacteriaceae levels below at £100 cfu/g. In this study the Enterobacteriaceae count was used as an indicator for possible irradiation or heat treatment of spices and herbs. Samples that had an Enterobacteriaceae count of ≤100 cfu/g were therefore considered as possibly having been irradiated or submitted to heat treatments.

**Product Information in relation to microbiological quality**

***Product Detail***

Using the classification of dried herbs and spices within Recommendation 2004/24/EC[13] (Table 7), 18% of batches/samples were categorised as *Capsicum* spp., 12% were *Piper* spp., 44% were other spices, and 26% were dried herbs. The proportion of herb samples of unsatisfactory microbiological status was higher (6%) when compared to all other spice types (3-4% ($p=0.0013$) (Table 7). The proportion of sage and basil samples of unsatisfactory status was significantly higher (19% and 13%, respectively) when compared to other dried herb types (0-8%) ($p<0.0001$) (Table 7).

**Table 7. Microbiological status of dried spices and herbs according to Recommendation 2004/24/EC[13] and ESA[12] specifications in relation to type of spices or herbs**

| Type of Spice or Herb | No Batches and Samples | | No Batches and Samples of Unsatisfactory Quality (%) |
|---|---|---|---|
| | (n= 2965) | % | |
| ***Capsicum* spp. (n= 552)** | **552** | **18%** | **17 (3%)** |
| Chilli | 260 | 47% | 9 (3%) |
| Cayenne | 78 | 14% | 7 (9%) |
| Paprika | 214 | 39% | 1 (0.5 %) |
| ***Piper* spp. (n=355)** | **355** | **12%** | **15 (4%)** |
| Black pepper | 243 | 8 | 13 (5%) |
| White pepper | 70 | 2 | 2 (3%) |
| Green pepper | 8 | 0.1 | - |
| Other (mixed, red peppers, flower pepper) | 34 | 1 | - |
| **Other Spices (n= 1292)** | **1292** | **44%** | **42 (3%)** |
| Aniseed | 47 | 2 | 1 (2%) |
| All spice | 22 | 1 | 2 (9%) |
| Cinnamon | 135 | 5 | 1 (1%) |
| Cumin | 166 | 6 | 4 (2%) |
| Fennel | 40 | 1 | 1 (3 %) |
| Garam Masala | 92 | 3 | 6 (7%) |
| Ginger | 130 | 4 | 5 (4%) |
| Mace | 9 | 0.3 | - |
| Mustard | 38 | 1 | - |
| Nutmeg | 92 | 3 | - |
| Saffron | 2 | 0.1 | - |
| Turmeric | 163 | 6 | 10 (6%) |
| Other (tikka/ tandori masala, coriander powder) | 356 | 11 | 12 (3%) |
| **Dried Herbs (n= 766)** | **766** | **26%** | **48 (6%)** |
| Basil | 71 | 2 | 9 (13%) |
| Bay | 26 | 1 | - |
| Coriander | 148 | 5 | 12 (8%) |
| Oregano | 67 | 2 | 3(4%) |
| Parsley | 72 | 2 | 1 (1%) |
| Rosemary | 58 | 2 | - |
| Sage | 48 | 2 | 9 (19%) |
| Thyme | 50 | 2 | - |
| Tarragon | 28 | 1 | - |
| Other (dill, fenugreek, lemongrass, coltsfoot) | 198 | 7 | 14 (7%) |

Of the spice and herb samples collected, more than half were ground types (58%, 1721/2965) (Table 8). Significantly, a higher proportion of spices and herbs collected as flakes (9%) were of unsatisfactory microbiological quality compared with samples that were whole (2%), ground (2%) or in other formats (3%, i.e. granules, pieces) ($p<0.0001$) (Table 8).

More than three-quarters (2277/2695; 77%) of the samples were pre-packed (Table 8). There was no difference in the proportion of spices and herbs collected as pre-packed packs (4%) or from opened packs at the premises (4%) that were of unsatisfactory microbiological status (Table 8).

The condition of most (2666/2965; 90%) spices and herbs sampled were recorded as ready-to-use (Table 8). There was no difference in the proportion of spices and herbs collected that were 'ready-to-use' (4%) or destined for further processing (4%) that were of unsatisfactory microbiological status (Table 8).

For most samples collected (2711/2965; 91%) there was no information to determine whether they had received a processing treatment or not (Table 8). However, 2% (74) of samples were labelled as having had received a processing treatment, while 6% (180) had not (Table 8). A higher proportion (11/180; 6%) of samples that had not received any treatment were of unsatisfactory microbiological status compared to those that had (2/74; 3%), although this finding was not statistically significant (Table 8) (p=1.0000).

Of the samples labelled as having had a treatment, 53% (39/74) were treated with hot air, 16% were steam treated, and additionally 31% were freeze-dried (Table 8). Significantly a greater proportion of samples that had been freeze-dried (9/23; 39%) were of unsatisfactory microbiological status compared to those that had received hot air (1/39; 3%) or steam (1/12; 8%) treatment (Table 8) (p = 0.0003). Twenty-two percent (16/74) of samples were treated in the UK, 74% were treated before export to the UK, and for 4% this information was not known (Table 8).

There was no evidence of mould growth in the majority (2819/2965; 95%) of samples. (Table 8). A higher proportion (2/7; 28%) of samples that were of unsatisfactory status were contaminated with mould when compared with samples that were not (118/2819; 4%). However, it should be noted that the proportion of samples with evidence of mould growth was very small and that no statistical conclusions should be drawn from these results.

**Table 8. Microbiological status of dried spices and herbs according to Recommendation 2004/24/EC[13] and ESA[12] specifications in relation to product detail**

| Product Detail | No Batches and Samples | | No Batches Samples of Unsatisfactory Quality (%) |
|---|---|---|---|
| | (n= 2965) | % | |
| ***Type of spice or herb: texture is tactile not format*** | | | |
| Whole | 420 | 14 | 9 (2%) |
| Ground | 1721 | 58 | 68 (2%) |
| Flakes | 326 | 11 | 29 (9%) |
| Other (e.g. granules, pieces) | 142 | 5 | 4 (3%) |
| Not recorded | 356 | 12 | 12 (3%) |
| ***Type of packaging*** | | | |
| Open pack | 655 | 22 | 29(4%) |
| Unopened / sealed pack | 2277 | 77 | 91 (4%) |
| Not recorded | 33 | 1 | 2 (3%) |
| ***Sample status*** | | | |
| Ready-to-use | 2666 | 90 | 106 (4%) |
| Destined for processing as part of food manufacturing process | 118 | 3.7 | 5 (4%) |
| Destined for packing in the UK | 9 | 0.3 | - |
| Not known | 172 | 6 | 11 (6%) |
| ***Product been treated*** | | | |
| Yes | 74 | 2 | 2 (3%) |
| No | 180 | 6 | 11(6%) |
| Not known | 2711 | 91 | 109(4%) |
| ***Treatment*** **(n= 74)** | | | |
| Hot air treatment | 39 | 53 | 1 (3%) |
| Steam treatment | 12 | 16 | 1 (8%) |
| Freeze dried | 23 | 31 | 9 (39%) |
| ***Treated in UK*** **(n= 74)** | | | |
| Yes | 16 | 22 | 1 (6 %) |
| Before export to the UK | 55 | 74 | 1 (2%) |
| Not Known | 3 | 4 | - |
| ***Evidence of mould growth*** | | | |
| Yes | 7 | 0.2 | 2 (28%) |
| No | 2819 | 95 | 118 (4%) |
| Not known | 139 | 4.8 | 2 (1%) |

## Country of Origin

A fifth (21%) of the spices and herbs collected were produced outside the EU, and of these 57% (356/619) were produced in India (Table 9). The proportion of samples produced by non-EU countries of unsatisfactory microbiological status was significantly higher (6%; 37/619) than those produced within the EU (1%; 4/307) (P=0.0006).

**Table 9. Microbiological status of dried spices and herbs according to Recommendation 2004/24/EC[13] and ESA[12] specifications in relation to the country of origin**

| Country of origin | Number of Batches and Samples | | No. Batches and Samples of unsatisfactory quality (%) |
|---|---|---|---|
| | n = 2965 | % | |
| **UK** | **148** | **5** | **-** |
| | | | |
| **Other EU** | **159** | **5** | **4 (3%)** |
| France | 7 | 4 | - |
| Germany | 10 | 6 | - |
| Spain | 102 | 64 | 1 (1%) |
| Other (Greece, Bulgaria, Ireland, Italy and others) | 40 | 26 | 3 (7.5%) |
| | | | |
| **Non- EU** | **619** | **21** | **37 (6%)** |
| Australia | 5 | 1 | - |
| Brazil | 5 | 1 | 1 (20%) |
| Canada | 15 | 2 | - |
| China | 65 | 11 | 2 (3%) |
| Egypt | 36 | 6 | 6 (17 %) |
| Guatemala | 15 | 2 | - |
| India | 356 | 57 | 16 (5%) |
| Indonesia | 22 | 4 | 2 (9%) |
| Other (Iran, Jamaica, Japan, Korea, Mexico and others) | 100 | 16 | 10 (10 %) |
| | | | |
| **Produce of more than one country** | **136** | **5** | **19 (14%)** |
| **Not known** | **1903** | **64** | **62 (3%)** |

## Premises details in relation to microbiological quality

## Type of premises

### *Food premises*

Almost half of the spices and herbs were collected from supermarkets (29%) and convenience stores (20%). Samples were also collected from market stalls (3%), delicatessens (5%) and catering premises (16%) (Table 10). Significantly a higher proportion of samples of unsatisfactory microbiological quality were collected from convenience stores compared with those from supermarkets (p=0.0001).

***Production premises***

Most (78%) production spices and herbs were collected from manufacturers (47%) and packing centres (31%). No significant difference was observed in the proportion of samples of unsatisfactory microbiological status collected from the different production premises (Table 10).

Additionally 40 batches of dried herbs and spices were collected at border inspection posts (BIPs), with four (10%) of the batches found to be of unsatisfactory microbiological status.

***Food Hygiene Inspections***

Forty-four percent of samples were collected from premises categorised as inspection rating Category C (inspected every 18 months) (Table 10). The proportion of samples of unsatisfactory status was similar from premises with inspection rating categories A to F (ranging from 2-5%).

The majority of samples were obtained from premises categorised in consumer at risk score 5 (few numbers of customers, 59%) and 10 (intermediate numbers of customers, 18%) (Table 10). The proportion of samples of unsatisfactory status was similar from premises rating with different consumer at risk scores (ranging from 2-5%) (Table 10) (P= 0.6755)

Most samples (67%) were collected from premises that had a confidence in management score of 5 (moderate confidence in management/control systems 30%) or 10 (some confidence in management/control systems, 37%) (Table 10). Significantly a greater number of spices and herbs of unsatisfactory status were obtained from premises with high scores (13%, i.e. little or no confidence in the management) compared to those with a low score (10%, i.e. some to high confidence in management) (Table 10) (p=0.0001).

## Table 10. Microbiological status of dried spices and herbs according to Recommendation 2004/24/EC[13] and ESA[12] specifications in relation to premises details

| Premises Details | | No. Batches and Samples | | No batches and samples of Unsatisfactory Quality (%) |
|---|---|---|---|---|
| | | (n= 2922) | % | |
| ***Retail Premises Type (n=2833)*** | | **2833** | **97** | **111 (4%)** |
| Supermarket | | 826 | 29 | 15 (2%) |
| Convenience store | | 598 | 21 | 34 (6%) |
| Market stall | | 88 | 3 | 4(5%) |
| Delicatessen | | 144 | 5 | 7 (5%) |
| Catering premises | | 446 | 16 | 15(3%) |
| Other (Butcher shops, farm shops, health food shops, specialist shops ) | | 730 | 26 | 36 (5%) |
| ***Production Premises Type (n=89)*** | | **89** | **3** | **6 (7%)** |
| Importers | | 14 | 16 | 2 (14%) |
| Packing centre | | 28 | 31 | 2 (7%) |
| Wholesalers | | 5 | 6 | 1 (20%) |
| Manufacturers | | 42 | 47 | 1 (2%) |
| ***Inspection Rating Category*** | | | | |
| Category | Minimum Frequency of inspection | | | |
| A | At least every 6 months | 61 | 2 | 1 (2%) |
| B | At least every 12 months | 287 | 10 | 12 (4%) |
| C | At least every 18 months | 1316 | 44 | 53 (4%) |
| D | At least every 2 years | 451 | 15 | 15 (3%) |
| E | At least every 3 years | 286 | 10 | 10 (3%) |
| F | At least every 5 years | 78 | 3 | 4 (5%) |
| Not recorded | | 443 | 16 | 22(7%) |
| ***Consumer at Risk Score*** | | | | |
| 0 (Very few) | | 46 | 2 | 2 (4%) |
| 5 (Few) | | 1721 | 59 | 72 (4%) |
| 10 (Intermediate) | | 522 | 18 | 12 (2%) |
| 15 (Substantial) | | 119 | 4 | 6 (5%) |
| Not Recorded | | 514 | 18 | 25 (5%) |
| ***Confidence in Management*** | | | | |
| 0 (High) | | 161 | 5 | 5 (3%) |
| 5 (Moderate) | | 875 | 30 | 24 (3%) |
| 10 (Some) | | 1096 | 37 | 49 (4%) |
| 20 (Little) | | 243 | 8 | 12 (5%) |
| 30 (None) | | 25 | 1 | 2 (8%) |
| Not Recorded | | 522 | 18 | 25 (5%) |
| ***Hazard Analysis Systems*** | | | | |
| In place and documented | | 1100 | 38 | 35 (3%) |
| In place and not documented | | 590 | 20 | 34 (6%) |
| Not in place | | 651 | 22 | 25 (4%) |
| Not Recorded | | 581 | 20 | 19 (3%) |
| ***Management Food Hygiene Training*** | | | | |
| **Received training and attended** | | **1853** | **63** | **65 (3%)** |
| ❖ *Basic 6 hour course* | | *1290* | *69* | 47 (4%) |
| ❖ *Intermediate course* | | *261* | *14* | 7 (3%) |
| ❖ *Advanced course* | | *93* | *5* | 3 (3%) |
| ❖ *Other recognised course* | | *209* | *11* | 2 (1%) |
| **No training** | | **565** | **19** | **29 (5%)** |
| **Not Recorded** | | **504** | **19** | **23 (5%)** |

### *Hazard analysis systems*

Fifty eight percent of samples were collected from premises that had hazard analysis in place (Table 10). A similar proportion of spices and herbs of unsatisfactory status were collected from premises that had hazard analysis in place (3%) compared to premises that did not (4%).

### *Food Hygiene Training*

Sixty three percent of samples were collected from premises whose managers had received some form of training (Table 10). A higher proportion of samples of unsatisfactory quality were from premises where the manager had not received food hygiene training (5%) compared to those that had (3%), although this finding was not significant (p=0.0185).

## Discussion

Dried spices and herbs are used in a variety of ways by manufacturers, caterers and the public, and microbiological concerns of these products are governed by end use. Although spices and herbs are not major contributors to foodborne disease, a potential hazard exists, particularly if the spice or herb is added at the end of cooking or added to prepared foods without further cooking[7,21]. The establishment of microbiological specifications, such as those by Codex[10] and ESA[12], are related to the final use of spices and herbs and require that *Salmonella* should be absent in treated spices and herbs and free from pathogenic microorganisms in levels that may represent a hazard to health. This study has shown that the vast majority of dried spices and herbs sampled at retail (96%) and (92%) production premises in the UK were of satisfactory or acceptable microbiological quality according to microbiological criteria in the EC Recommendation 2004/24/EC[13] and ESA specifications[12].

*Salmonella* spp. have been found in a wide variety of herbs and spices with rates of contamination ranging between 0.6% and 14%[3,4,6,21-23]. The prevalence of *Salmonella* spp. in dried spices and herbs in the UK in 2004 (1%) was similar to that found in Ireland (0.9%; in 2004)[22], Japan (0.7%; in

2006)[4], and Austria (0.6%; in 1994)[3], but lower than that previously found in Australia (2.0%; in 1986)[6], the USA (6.5%; in 1987)[23], and the UK (12.3%; in 1996, C Little, HPA pers comm). The presence of *Salmonella* spp. is of particular concern when herbs and spices are added to ready-to-eat foods, and contaminated spices have been responsible for outbreaks of salmonellosis[5-8].

Spore forming bacteria (*B. cereus*, *C. perfringens*) that are capable of causing foodborne disease when ingested in large numbers are frequently found in spices and herbs, but usually at low levels[21]. Levels of *B. cereus* at ≥$10^4$ cfu/g in herbs and spices in the UK in 2004 (1%) were lower than that previously found in the UK (1.9%; in 2003)[7]. *B. cereus* at ≥$10^4$ cfu/g has also been reported in a variety of herbs and spices sampled in Australia, Hungary, Ireland, Italy, The Netherlands, and the USA, with the proportion ranging between 0% to 6.5%[6,22,24-28]. *B. subtilis* is commonly found in many spices[21] and of the *Bacillus* spp. at high levels (≥$10^5$ cfu/g) in this study, over half (58%) were identified as *B. subtilis.* However, *B. subtilis* has only occasionally been a cause of food poisoning linked to spices[7,29]. *C. perfringens* has also been found in several spices usually at <500 cfu/g and rarely ≥$10^3$ cfu/g[21]. *C. perfringens* at ≥$10^3$ cfu/g in herbs and spices in the UK in 2004 was 0.4%. In other studies *C. perfringens* at ≥$10^3$ cfu/g ranged from 0% to 7.6%[6,21,27,30]. Because spores of the above organisms may survive cooking temperatures and may multiply to high levels in foods held at room temperatures, a risk of food poisoning by these pathogens may be created when no proper time-temperature conditions for heating, cooling and storage of foods seasoned with spices or herbs are applied.

All spices and herbs are susceptible to microbial contamination. The prevention of microbial contamination in dried herbs and spices lies in the application of good hygiene practices during growing, harvesting and processing from farm to fork, and effective decontamination. Codex has produced a Code of Hygienic Practice for dried herb and spice suppliers[10] to help minimize microbial food safety hazards. The EC Regulation on the hygiene of foodstuffs[31] advocates the principles of HACCP and the

establishment of in-process controls to ensure product integrity, rather than reliance on end-product testing for compliance with specifications. In the spice and herb industry the strengthening of HACCP systems that encompass all stages of production, processing and distribution will serve to further enhance the microbial safety of these products. In addition, educating food handlers and consumers as to the importance of correct food handling practices will also help to prevent foodborne illness due to contaminated spices and herbs.

## Acknowledgements

The authors would like to thank all the staff in the Environmental Health Departments throughout the UK who collected samples for this study, and all the staff in both HPA, HPA collaborating and non-HPA laboratories who performed the microbiological examinations. Thanks are extended to FSML and LEP, HPA Centre for Infections for typing isolates, to David Lock at LACORS for co-coordinating the participation of Environmental Health Practitioners, to the Regional Food, Water and Environmental Co-coordinators Forum for advice on the sampling protocols, and to Lilian Hucklesby for co-ordinating data entry.

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## Annex 1

**Table 1. *B. cereus* and *Bacillus* spp. isolated from dried spices and herbs (*Total No. = 626; of these 399 samples were not sent for further typing)**

| Type of Sample | No. of Batches/ Samples | *Bacillus* spp.* |
|---|---|---|
| ***Dried Spices:*** | | |
| All spice | 8 | *Bacillus* spp (5)*<br>*B. subtilis*<br>*B. licheniformis*<br>*B. licheniformis* / *B. subtilis* |
| Aniseed | 1 | *B.subitils* |
| Chill (Powdered, flakes and Ground) | 120 | *Bacillus* spp. (68)*<br>*B. lichenformis* (3)<br>*B. pumilus* (3)<br>*B. cereus* (10)<br>*B. subtilis* (30)<br>*B. amyloliquefaciens*,<br>*B. subtilis* / *B. licheniformis*<br>*B. subtilis* / *B. pumilus* (3)<br>*B. subtilis* / *B. pumilus*/ *B. licheniformis* |
| Coriander (Ground) | 9 | *Bacillus* spp. (6)*<br>*B. cereus*<br>*B. pumilus* / *B. licheniformis*<br>*B. pumilus* / *B. cereus* |
| Cumin | 9 | *Bacillus* spp. (6)*<br>*B. licheniformis*<br>*B. subtilis*<br>*B. subtilis*/ *B. pumilus* |
| Curry powder | 45 | *Bacillus* spp.(28)*<br>*B. pumilus*<br>*B. cereus*<br>*B. subtilis* (7)<br>3 x *B.subtilis*/ *B. pumilus* (3)<br>*B. subtilis*/ *B. licheniformis*<br>*B. subtilis*/ *B. licheniformis*/ *B. cereus* (2)<br>*B. subtilis*/ *B. licheniformis*/ *B. pumilus* / *B. cereus*<br>*B. cereus* / *B. subtilis* |
| Garam masala | 53 | *Bacillus* spp. (38)*<br>*B.subtilis* (7)<br>*B. cereus*<br>*B. pumilus* (2)<br>*B. licheniformis*,<br>*B. cereus*/ *B. subtilis*<br>*B. subtilis*/ *B. pumilus*<br>*B. pumilus*/ *B. Licheniformis* |
| Ginger | 18 | *Bacillus* spp. (9)*<br>*B.cereus*<br>*B. subtilis* (4) |

| | | |
|---|---|---|
| | | *B. pumilus*<br>*B.subtilis*/ *B. pumilus* (3) |
| Mixed spices | 7 | *Bacillus* spp. (6)*<br>*B. pumilus* / *B. cereus* |
| Nutmeg | 2 | *Bacillus* spp. (2)* |
| Paprika | 49 | *Bacillus* spp. (27)*<br>*B. subtilis* (13)<br>*B. cereus*<br>*B. pumilus*<br>*B. pumilus*/ *B. cereus*/ *B. subtilis*<br>*B. subtilis*/ *B. pumilus*/ *B. licheniformis*<br>*B. subtilis* / *B. licheniformis*<br>*B. subtilis* / *B. pumilus* (4) |
| Pepper (black) | 134 | *Bacillus* spp. (96)*<br>*B. cereus* (2)<br>*B. subtilis* (21)<br>*B. pumilus*/ B. *subtilis* (8)<br>*B. pumilus*/ *B. circulans*<br>*B. pumilus*/ *B. lichenformis*<br>*B. subtilis* / *B. cereus* (2)<br>*B. subtilis* / *B. pumilus*/ *B. cereus*<br>*B. subtilis* / *B. pumilus*/ *B. lichenformis* |
| Pepper (red) | 3 | *Bacillus* spp. (2)*<br>*B. subtilis* / *B. pumilus* |
| Pepper (White) | 1 | *Bacillus* spp. * |
| Pepper (mixed) | 3 | *Bacillus subtilis* (3) |
| Saffron | 1 | *Bacillus* spp.* |
| Trumeric | 68 | *Bacillus* spp. (28)*<br>*B. subtilis* (23)<br>*B. cereus*<br>*B. pumilus* (2)<br>*B. licheniformis* (4)<br>*B. subtilis*/ *B. licheniformis* (5)<br>*B. licheniformis* / *B. cereus*<br>*B. cereus*/ *B subtilis*<br>B. *subtilis*/ *B. pumilus*<br>*B. subtilis* / *B. lichenformis*/ *B. pumilus* |
| Other | 80 | *Bacillus* spp. (48)*<br>*B. subtilis* (14)<br>*B. pumilus* (3)<br>*B. cereus* (8)<br>*B. pumilus* / *B. cereus* (2)<br>*B. pumilus*/ *B. subtilis* (2)<br>*B. pumilus*/ *B. lichenformis*<br>*B. lichenformis* / *B. subtilis*<br>*B. subtilis*/ *B. lichenformis*/ *B. cereus* |
| ***Dried Herbs:*** | | |
| Basil | 5 | *Bacillus* spp. (3)*<br>*B.subtilis*<br>*B. pumilus* |

| | | |
|---|---|---|
| Dill | 1 | *Bacillus* spp.* |
| Fenugreek | 1 | *Bacillus* spp.* |
| Mint | 2 | *Bacillus* spp. (2) |
| Sage | 1 | *Bacillus* spp.* |
| Tarragon | 1 | *Bacillus* spp.* |
| Thyme | 1 | *B. lichenformis* |
| Other (Lemon grass) | 2 | *B. subtilis*<br>*B. subtilis*/*B .cereus* |

## Annex 2: Participating Laboratories and Local Authority Food Liaison Groups

### Table I: Participating HPA and HPA Collaborating Laboratories and number of samples

| HPA Region | Laboratory Name | No. of Samples |
|---|---|---|
| East | Chelmsford | 163 |
| | Norwich | 104 |
| London | London FWEM[1] | 186 |
| South East | Ashford | 94 |
| | Brighton | 193 |
| | WEMS[2] | 273 |
| West Midlands | Birmingham | 75 |
| | Coventry | 169 |
| | Shrewsbury & Telford | 56 |
| | Stoke | 59 |
| | Hereford | 20 |
| North West | Chester | 52 |
| | Preston | 240 |
| | Carlisle | 26 |
| North East, Yorkshire & the Humber | Hull | 95 |
| | Leeds | 82 |
| | Newcastle | 53 |
| | Sheffield | 262 |
| South West | Bristol | 92 |
| | Exeter | 84 |
| | Plymouth | 25 |
| | Truro | 62 |
| East Midlands | Leicester | 94 |
| | Lincoln | 210 |
| **Total** | | **2769** |

1, London Food, Water & Environmental Microbiology Laboratory
2, Wessex Environmental Microbiological Services

### Table II: Participating Other Laboratories and number of samples

| Nation | Laboratory | No. of Samples |
|---|---|---|
| England | Kings Lynn & West Norfolk | 12 |
| | Worcester Scientific Services | 16 |
| Northern Ireland | Belfast City Hospital | 60 |
| | Royal Alexandria, Paisley | 4 |
| Scotland | Aberdeen City Council Public Analysts | 32 |
| | Dundee Scientific Services | 4 |
| | Glasgow Scientific Services | 9 |
| Wales | Bangor | 35 |
| | Rhyl | 24 |
| **Total** | | **196** |

## Table III: Participating Food Safety Liaison Groups and number of samples

| Local Authority Food Liaison Group | No. of Samples |
|---|---|
| Berkshire | 44 |
| Buckinghamshire | 23 |
| Cambridgeshire | 67 |
| Cheshire | 23 |
| Cornwall | 44 |
| Cumbria | 43 |
| Derbyshire | 167 |
| Devon | 76 |
| Dorset | 25 |
| Durham | 6 |
| East Sussex | 67 |
| Essex | 78 |
| LFCG[1] Greater London NE Sector | 53 |
| LFCG Greater London NW Sector | 59 |
| LFCG Greater London SE Sector | 31 |
| LFCG Greater London SW Sector | 33 |
| Greater Manchester | 106 |
| Hampshire & Isle Of Wight | 167 |
| Hereford & Worcester | 36 |
| Hertfordshire & Bedfordshire | 10 |
| Humberside | 83 |
| Kent | 94 |
| Lancashire | 112 |
| Leicestershire | 89 |
| Lincolnshire | 94 |
| Merseyside | 24 |
| North Yorkshire | 40 |
| Northamptonshire | 87 |
| Northern Ireland Food Group[2] | 60 |
| Norfolk | 97 |
| Nottinghamshire | 108 |
| Oxfordshire | 18 |
| Scottish Food Enforcement Liaison Committee[3] | 55 |
| Shropshire | 33 |
| Somerset | 34 |
| South West Yorkshire | 103 |
| Staffordshire | 59 |
| Suffolk | 48 |
| Surrey | 77 |
| Tyne & wear | 34 |
| Wales North Group | 58 |
| Wales South West Group | 6 |
| Warwickshire | 84 |
| West Midlands | 102 |
| West of England | 58 |
| West Sussex | 54 |
| West Yorkshire | 54 |
| Wiltshire | 42 |
| **Total** | **2965** |

1, London Food Co-ordinating Group
2, Northern Ireland Food Group comprises of the Eastern, Northern, Southern and Western Groups
3, SFELG comprises of Central Scotland, Fife & Tayside, Lothian & Scottish Borders, North Scotland, and West of Scotland