RISK OF FOOD POISONING DUE TO THE PRESENCE OF HUMAN PATHOGENS IN SPROUTED SEEDS

FOOD STANDARDS AGENCY - SUMMARY PAPER

Background

1. Food poisoning outbreaks throughout the world have been and continue to be associated with the consumption of sprouted seeds, although there have been none reported in the UK since 1989. Outbreaks are particularly frequent in the US.

2. The largest single outbreak, involving radish sprouts contaminated with *E. coli* O157:H7, affected more than 6,000 people in Japan in 1996. The scale of most *Salmonella* outbreaks in the US and abroad has been 20-200 people and most were associated with alfalfa sprouts.

3. In the US in 1998, precautionary advice was issued by the US Food and Drug Administration (FDA) that high-risk groups (young, elderly, pregnant women and patients suffering from depressed immune systems) should avoid the consumption of raw alfalfa sprouts. In November 2002, following a number of new outbreaks, this advice was extended to raw and lightly-cooked mung bean sprouts.

4. In July 2002, the Food Standards Agency initiated an investigation into the risks to consumers in the UK from the consumption of sprouted seeds. In particular this was to determine whether circumstances were similar to the US and if it might therefore be necessary to issue precautionary advice in line with the US. This investigation is now complete.

Studies

5. Information was obtained using the services of consultants. Consultancy work was divided into two parts. The first group examined the market, supply chain and production processes and spoke to producers in the UK to determine the current state of the industry and to assess the potential for improvement.

6. The second group carried out a literature-based exercise to examine the risks associated with each stage of the production and supply chain and to review published research into the avoidance, minimisation and removal of pathogenic organisms. This work was reinforced by the use of personal contacts to obtain details of ongoing research both in the UK and abroad.

7. The purpose of this paper is to assess the outcome of these studies and to consider what action might be appropriate for the UK.

Food poisoning outbreaks

8. Most reported outbreaks associated with sprouted seeds have involved either *Salmonella* species or *E. coli* O157:H7, although a very small number

of cases have implicated other bacterial pathogens e.g. *Bacillus cereus* and *Yersinia enterocolitica*. There are no reported outbreaks attributed to foodborne viruses or protozoa.

9. A summary of outbreaks is listed in Annex 1. Approximately half of the reported outbreaks occurred in the US. The majority was attributed to contamination of the original seed, although there is some variation in the quality of the investigations and the level of confidence in the outcome. There appears to be a slight fall-off in frequency over the past two years, but this may be due to delays in the full publication of reports.

Market and Supply Chain

10. Sprouts are produced by the rapid germination of seeds and beans. A wide variety can be grown in this way although only a limited number are commercially significant.

11. In the UK, it is predominantly mung bean sprouts (also referred to as beansprouts or beanshoots) that are sold in UK supermarkets and greengrocers, as well as being used in catering. Mustard and cress and ‘salad’ (rape) cress are widely used in salads and sandwiches. In contrast, certain sprouted seeds that are significant abroad, for example alfalfa and radish, are still comparatively uncommon in the UK.

12. The exact size of the UK market is not known but is estimated, on the basis of seed import figures, at 30-45,000 tonnes per annum of mung bean sprouts, divided about equally between retail, catering and processed foods. Consumption of other sprouts, notably alfalfa, is negligible in comparison, although there are indications of an increase in popularity.

13. There are no more than four major producers in the UK, and perhaps 8-12 smaller producers. These include at least two organic producers.

14. The mung beans used for sprouting in the UK are sourced mainly from Australia, China, Mongolia and Burma. Those used by the larger sprout producers are usually imported with full traceability back to growers, although beans are also available as a commodity for spot purchase.

15. The US market in 1998 was estimated at about 350,000 tonnes, a significant proportion of which is alfalfa. The US is estimated to have up to 400, generally small, producers.

16. US consumption patterns are largely influenced by Vietnamese and Cambodian cultures, in which sprouts are eaten raw, in contrast to the UK, which is based on Cantonese cuisine (cooked).

Production

17. Beansprouts are produced from seeds over 2-10 days, depending on the type of seed and the size of sprout required. After soaking, seeds normally germinate within 24 hours and are sprouted in tanks under warm, dark, humid conditions, with regular irrigation. These growing conditions are

ideal for the growth of a number of human pathogens including Salmonellae and *E. coli* O157. No soil, which would be a potential source of pathogens, is used in the process.

18. Mature sprouts are washed vigorously to remove husk and roots. However, there is no certainty that washing will remove pathogens, even from the sprout surface, and therefore the final wash is normally carried out using chlorinated water. This may assist in the removal of any surface contamination but is unlikely to affect the levels of internalised organisms.

19. The typical shelf life of packaged sprouts is 3-4 days.

Quality Assurance and Critical Control Points

20. The due diligence requirement, which is currently unique to the UK, is obliging UK retailers to insist on a high degree of control on the part of the producers. In the US there is great reluctance to adhere to anything other than strict legal requirements. This in turn means that UK producers have much greater concern about the integrity of the supply chain than would be the case in the US.

21. Pathogenic bacteria can be internalised in seeds as a result of poor hygiene during cultivation of the seed plants themselves. Contamination introduced into the seed during the growing stage can survive and proliferate during sprouting. It must therefore be prevented by adhering strictly to Good Agricultural and Good Hygiene Practices. Although some types of seed may be more prone to internalisation than others due to morphological differences, the principle requirements of GAP and GHP would apply equally to all. As a consequence of due diligence requirements, UK beansprout producers work closely with the seed suppliers to ensure compliance with the highest standards of practice in these areas.

22. In general, seeds are routinely tested for microbial contamination at harvest and prior to import. The very low rate of rejection demonstrates that hygienic production is readily achievable. In the case of mung, this is undoubtedly aided by the fact that mung plants grow best in harsh, dry conditions in which frequent irrigation and the application of fertiliser, either of which could provide a pathway for contamination, are unnecessary.

23. Contamination can also be introduced during harvesting, handling, packing and transportation. The continued observance of good hygiene practices is therefore essential and is again subject to close supervision as a result of producer requirements. Seeds are purchased to a tight specification, including a detailed microbiological profile.

24. In the US, alfalfa is produced mainly as an animal fodder crop and seeds used for sprouting are often taken from a common supply. This can be a particular problem as hygiene practices during growing, harvest and handling are likely to be of a lower standard than those for a food crop. Furthermore, most seeds used for sprouting in the US are grown internally

and consequently lack the additional control provided by import, as well as the traceability demanded by UK sprout producers.

25. Decontamination of seeds prior to sprouting is considered as a critical control point. Substantial research has already been carried out into potential methods, and novel techniques are currently under evaluation in the UK and abroad. However, no technique has yet been brought into widespread use that can guarantee to eliminate internalised pathogens from seeds without adversely affecting germination. Current US practice is to soak seeds in 20,000 ppm calcium hypochlorite, which has not prevented at least one outbreak. Further research to develop more reliable decontamination methods may be necessary.

26. Trial sprouting in potable water of samples taken from seed batches, without the use of any chlorine, and with subsequent microbiological testing, appears to give a greater likelihood of detecting contamination than testing of the seeds directly. However there will clearly still be sampling limitations, especially if the contamination is not evenly distributed through the seed batch. It has been suggested that this might be an area for further research and methodology development, particularly in terms of appropriate sampling.

27. Other than the beans themselves, the most likely sources of contamination during the sprouting process itself are dirty equipment, irrigation water and operators.

28. Sprouting conditions are ideal to promote the growth of pathogenic organisms. It is therefore essential to carry out production under hygienic conditions. The CCFRA Guidelines, produced in 1989, are normally used as a basis for good hygienic production standards, although many producers have commented that these are now outdated and that they have made various improvements, either on their own initiative or at the request of major customers. Control measures would normally include an initial chlorine soak (though not at the strength used in the US) and a final product wash with chlorinated water, although potable water is used for the frequent irrigation required. Regular microbiological monitoring is carried out, as well as testing of the final product. Producers report that test failures are very rare.

29. Organic producers, who are not allowed to use chlorine, have ruled out the possible use of other disinfectants. It appears that they do not routinely use microbiological testing as a quality control but rely on visual examination of the seeds for dust and grit. The consultants' view is that this could pose a greater risk to consumers.

Legal status of sprouted seeds

30. The General Food Hygiene Regulations (GFHR) require food production processes to be hygienic, and producers must identify food safety hazards and ensure that controls are in place. However, primary produce is exempt. Although there can be no doubt that seeds and beans themselves are a primary product, the regulations do not contain detailed definitions, and it could be argued that beansprouts are also a primary product. That said,

processing and packaging would be caught under GFHR. Salad cress is regarded as a horticultural commodity.

31. Legal clarification of the status of sprouted seeds is unlikely to be forthcoming. However, it would probably be difficult to argue that the sprouting of seeds (as well as the seed production itself) is not primary production. In consequence the application of HACCP principles is not currently a legal requirement and nor will it be when the new consolidated food hygiene legislation is introduced. The consolidated legislation is, however, expected to introduce the requirement for a hazard-based approach in primary production. This will be coupled with the facility for Industry Guides on Good Hygiene Practice to be produced.

32. Possibly because of the confusion over the status of sprouted seeds there appears to not always be a consistent approach by Local Authority Enforcement Officers. Some appeared to be unaware of the existence of beansprout producers in their areas and may not fully appreciate the potential risk associated with beansprouts.

Research

33. Outbreak data indicate that the seed used for sprouting is the most significant source of the pathogens implicated. Not surprisingly, therefore, a great deal of research has been focussed on the development of methods to disinfect seeds prior to sprouting. The challenge is a particularly difficult one given that bacteria that are trapped in cracks and crevices in the seed coat appear to be protected from disinfectants and there is evidence that some bacteria can be internalised within the seed itself. Decontamination procedures can also adversely affect subsequent germination.

34. Considerable research into the use of chemical decontaminants has been described in the literature, together with more novel techniques and combinations of treatments. The range of chemical treatments studied includes hypochlorite, chlorine dioxide and acidified calcium chlorite, organic acids, hydrogen peroxide, ethanol, trisodium phosphate and calcium hydroxide. Other techniques investigated, or of potential interest, are high pressure, pulsed electrical and magnetic fields, ultra-violet and pulsed light. Ultrasound combined with chemical treatments has been described as enhancing pathogen reduction over chemical treatment alone.

35. Notwithstanding this considerable research effort, to date no technique has been shown to completely eradicate pathogenic micro-organisms from either the raw or sprouted seed. However, use of combinations of treatments may be closer to eliminating pathogens and further research in this area may be useful.

36. A more reliable decontamination method would provide producers and retailers with the added confidence to market sprouts consistently as a ‘ready to eat’ product, as opposed to the current position where most are marketed as ‘ready to cook’.

37. Given the difficulty of decontaminating seed another important aspect that has been looked at is the detection and isolation of pathogens from the seeds used to produce sprouts. This is thought to be intrinsically difficult due to the low level of contamination and inaccessibility in cracks, crevices and internally within the seed. Researchers have therefore looked at different sampling and detection methods. Further studies into establishing standard sampling and microbiological methods are suggested as being useful areas for further research.

Conclusions / Recommendations

38. There is a small identifiable risk associated with the consumption of sprouted seeds. However, the risks are well understood in the UK and good practices are applied at all stages of the supply chain in order to reduce risks to an acceptably low level.

39. General precautionary advice along the lines of that issued in the US seems unnecessary at present – although this will need to be kept under review.

40. There is a need for updated guidelines for the hygienic production of sprouted seeds that take account of current industry good practice. This could be approached in a number of ways, but the development of an Industry Guide to Good Hygiene Practice may be particularly beneficial and would anticipate the expected new European consolidated hygiene legislation. The guidelines could include discussion of appropriate temperature control requirements, an aspect highlighted by the consultants as requiring further consideration.

41. Updated guidance would benefit the industry, but could also be used by Local Authority Enforcement Officers. This would not only provide information, but also help promote consistency in enforcement.

42. It is thought that one of the possible reasons for less of a problem with sprouted seeds in the UK compared to the US is because we tend to eat different types of sprouts. However, there are indications that consumption patterns may be changing. It would be useful to seek sprouted seed producers views on this.

43. Further research may be needed in particular in relation to sampling and detection methods and seed decontamination methods.

ANNEX 1

Summary of outbreaks of foodborne illness associated with sprouted seeds

Year	Pathogen	Cases	Location(s)	Type of sprout	Likely source of contamination
1982	*Yersinia enterocolitica*	16	Pennsylvania	Mung	Irrigation water
1988	*S.* Saint-Paul, *S.* Havana; *S.* Muenchen	148	Sweden	Mung	ND
1988	*S.* Saint Paul	143	United Kingdom	Mung	Seed
1988	*S.* Virchow	7	United Kingdom	Mung	ND
1989	*S.* Gold-Coast	31	United Kingdom	Cress	Seed and/or sprout grower
1990	*S.* Anatum	15	Washington	Alfalfa	ND
1992	S. *enterica*	272	Finland	Alfalfa	ND
1994	*S.* Bovis mordificans	492	Finland, Sweden	Alfalfa	Seed
1995	*S.* Stanley	242	Finland, 6 US States	Alfalfa	Seed
1995	*S.* Newport	154	Denmark (Probably USA and Canada)	Alfalfa	Seeds
1995 /96	*S.* Newport	133	7 US States, Canada, Denmark	Alfalfa	Seed
1996	*E. coli* O157:H7	5,727	Japan	Radish	Seed
1996	*E. coli* O157:H7	126	Japan	Radish	Sprout growers
1996	*S.* Montevideo and *S.* Meleagridis	492	California, Nevada	Alfalfa	Seed and/or sprout grower
1997	*S.* Anatum & *S.* Infantis	109	Kansas, Missouri	Alfalfa	Seed
1997	*E. coli* O157:H7	79	4 US States	Alfalfa	Seed
1997	*E. coli* O157:H7	108	Michigan, Virginia	Alfalfa	Seed
1997	*S.* Meleagridis	78	Canada	Alfalfa	Seed (organic)
1997 /98	*S.* Senftenberg	60	California, Nevada	Alfalfa	Seed and/or sprout drum
1998	*S.* Havana	18	2 US States	Alfalfa	Seed
1998	*S.* Cubana	22	5 US States	Alfalfa	Seed
1998	*E. coli* O157:H7	8	California, Nevada	Alfalfa, Clover	Seed and/or sprout grower
1999	S. Mbandaka	75	4 US states	Alfalfa	Seed
1999	*S.* Muenchen	> 157	Multistate, USA	Alfalfa	Seed
1999	*S.* Saint-Paul,	36	California, USA	Clover	ND
1999	*S. paratyphi* var Java	51	Canada	Alfalfa	Seed
1999	S. *typhimurium*	120	Colorado	Alfalfa	Seed
2000	*Salmonella spp.*	22	California, USA	Alfalfa	ND
2000	S. *Enteritidis PT 4b*	27	The Netherlands	Mung	Seed
2000	*S. Enteritidis*	75	4 US states	Mung	ND
2001	*S. Enteritidis* PT 913	84	Canada	Mung	Seed
2001	*S.* Kottbus	31	4 US states	Alfalfa	Seed
2002	*S. Enteritidis*	n/a	Maine	Mung	ND
2003	*S.* Saint-Paul	>9	Oregon, Washington	Alfalfa	ND

ND = Not Determined