Animal health and food safety

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Foods of animal origin have an important role in a balanced diet and must be safe for human consumption. Equally important is the need for the food to be perceived as safe by the consumer. Safe food of animal origin must be free from animal pathogens that infect man and from contamination by residues. While intensive farming practices have been linked with the rise in foodborne illness in humans, it is interesting to note that the rise has continued even when there has been a shift to less intensive farm production systems. While the production of meat, milk and eggs, regardless of new technology or changes in production methods, cannot be expected to achieve zero bacterial risk, there is the need to reduce the risk and, where possible, eliminate it at the 'on the farm stage'. The current use of the terms 'farm-to-table', 'stable-to-table' and 'plough-to-plate' clearly identifies the farm as one part of the production chain which must be considered in terms of food safety.

Micro-organisms are widely present in animals and in their environment. With animals, disease is inevitable; perfectly healthy animals can also be carriers and may be asymptotic excretors of pathogens. The diseases of animals which affect the safety of food are predominantly those that cause enteric disorders. The prevalence of pathogens on the farm, or on a unit within a farm, depends on many factors, not least being the type of husbandry, the environmental pressure on that farm and the standard of stockmanship. There are organisms which are pathogenic to man but do not cause clinical illness in the animals, such as *Escherichia coli* O157, and others which are excreted in large numbers before there is evidence of the animal being unwell or following apparent recovery from an illness.

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Hazard analysis critical control point and livestock

Whenever food production and processing is mentioned in relation to food safety the use of the hazard analysis critical control point (HACCP) system is suggested. HACCP identifies and evaluates hazards and enables decisions on whether control, absolute or in part, can be applied to limit the hazards, and determines the methods for monitoring and controlling the process. The use of HACCP has become rather 'all things to all in the food industry', and perhaps even to different Governments but there is good reason for using HACCP principles behind the farm gate. In livestock production, there are a number of points where controls can be applied.

The first is with the birth of the animal, or at hatching in the case of poultry, and extends through all stages of animal production and includes the foodstuffs fed to the animals. The aim should be to have the young born fit and healthy with good levels of maternal immunity. In addition to the appropriate use of available vaccines in the neonate, vaccines can be given to the pregnant dam, such as the bovine combined rotavirus and K99 *E. coli* vaccine for calf scours, to protect the young in the first 2–3 weeks of life. Animals and birds are usually kept in groups, either outside in fields or housed for all or part of the year. The access to the housed accommodation or to the pasture may be voluntary or controlled according to the farming system in place. Whichever system is used, the animals must be kept in the very best conditions, with the aim being able to prevent disease in individual animals or the whole herd or flock. The type of husbandry directly impacts on this, as the most certain way to reduce or remove the risk of introducing disease organisms to animal(s) is to use biosecure housing. This, of course, is contrary to the trend towards extensive systems where there is the inevitable exposure to wild-life vectors of a number of important pathogens. The use of systems of production which have biosecure housing does allow a policy of 'all in, all out', followed by thorough cleaning and disinfection of the house before restocking, to be used. The original method was to apply this practice to each house as it was emptied of animals or birds. More recently, this practice has been extended to involve all animal accommodation on the site, which is emptied of livestock then all cleaned and disinfected before any unit on that site is restocked.

In addition to keeping animals healthy, a critical part of the husbandry is also to make sure they are kept visibly clean. It is of particular importance, to reduce the possibility of contamination of the food, for milking animals and for animals destined for slaughter not have dirty outer coats. A major influence on the cleanliness of the animals is the type of housing, the material used as bedding and the underfoot conditions if the animals are kept outside. There are a variety of housing systems in practice, including straw or deep litter yards, cow cubicles with straw, sand, rubber mats or even water-beds as bedding, and sheds with slatted floors, or a combination of these. Straw bedding is a much-favoured system for comfort and cleanliness, but is only satisfactory if the existing bedding is regularly replaced with clean straw. In some parts of the country, straw may not be available locally, which requires the transport of straw from the arable counties. A major factor in the effectiveness of any system in keeping the animals clean is the standard of the management. Failure to attend to detail will lead to an increase in environmental organisms and inevitably also pathogens. The stockman, therefore, has a crucial role to play both from the animal health and public health perspectives.

Food-stuffs which are fed to animals must be free from both pathogens and undesirable residues. The role of animal feed in food safety has been highlighted both in relation to salmonella, in particular *Salmonella enteritidis* phage type 4 in poultry[1,2], bovine spongiform encephalopathy in cattle (BSE)[3], and, more recently, dioxins in animal feeds in Belgium. Animal feeds are produced from both home-grown and imported ingredients most frequently as a compounded, nutritionally balanced, ration from commercial feed mills. The farmer may well prepare the feeds on the farm using either home-grown or purchased forage and cereals. The ingredients for animal feeds may carry pathogens. The process of producing some forms of compounded feed, such as pelleted feed, requires a heat treatment stage which is effective against bacterial pathogens; however, subsequent handling stages may allow recontamination. The farm does have a role to play in making sure the feed is stored in a manner which prevents contamination from external influences such as wild life on the farm.

The bringing on to the farm of new animals, whether as replacement breeding stock or animals to be fattened for slaughter, is frequently a way by which diseases are introduced. In most cases, the major impact will be from diseases which affect animals but frequently can include zoonotic organisms. It is of the utmost importance that incoming animals are kept separate from those already on the farm for the necessary period of quarantine and, where possible, come from a farm with a known health history.

Growth promotion techniques

There is also pressure on the industry to use production methods that will deliver the slaughter animal at a predetermined weight, with the required carcass conformation, in the shortest time and at the lowest possible cost. This has lead to the use of growth promotion techniques, including sub-therapeutic levels of antibiotics in the feed and steroid hormones during the growing phase. The use of substances having a thyrostatic, oestrogenic or gestagenic effect for growth promotion purposes has been prohibited within the EU, or for products to be imported into the EU, since January

1989. The counter argument to justify the use of steroid hormones is that they are naturally occurring substances and, if the withdrawal periods are followed, there is no risk to human health. This issue was reviewed by the Scientific Veterinary Committee on Matters Relating to Public Health in 1999. They considered that the scientific evidence necessary to make a balanced scientific judgement is lacking but it is known that one, 17β-oestradiol, is a complete carcinogen and, as such, is able to initiate and promote cancer. The Committee considered that there was sufficient uncertainty in terms of consumer public health that the ban on their use in the EU should continue[4].

The use of antibiotics, without veterinary prescription, for the purposes of increasing growth in food animal production, started in the early 1950s. Following an outbreak of food poisoning due to multi-drug resistant salmonella, an Expert Committee chaired by Professor Swann, reviewed the use of antibiotics in agriculture. Their report in 1969[5] resulted in significant changes in the use of antibiotics, including their use for growth promotion purposes. More recently, there has again been considerable concern about the use of antibiotics, especially for growth promotion purposes, in animals, and specifically about food being a vector of antibiotic resistance from animals to humans. This has led to a number of reports from groups of experts, nationally and internationally, considering the use of antibiotics in animals, in man and for plant protection purposes[6,7]. There is agreement that there should be prudent use of antibiotics in veterinary and human medicine, but little justification for the uncontrolled use of antibiotics at sub-therapeutic levels to promote growth. The major concern is if there is evidence of medical equivalence for the antibiotic, either where the same drug is used in man and in animals, or if there is known antibiotic resistance. Of major concern is where there is a possible impact on the effectiveness of important antibiotics used in human medicine, especially when the antibiotic is one of last choice for life-threatening infections. The growth promotion debate will undoubtedly continue, but already there is evidence of sectors of the industry stopping the use of antibiotic growth promoters as part of their production systems. It is easy to say that there should be no use of these products just to sustain cheap food production systems and make animals grow faster. However, some of the very same 'antibiotic growth promoters' also control disease in the animals and stopping their use would require a greater use of therapeutic antibiotics. There is a balance, which can be achieved between the two schools of thought, which requires the husbandry systems to be changed to reduce the need for use of antibiotics in any form. The issue of consumption of residues in food of animal origin is also important and there are established testing programmes for residues in meat and milk and a requirement only to use drugs which are licensed for use in food producing species within EU Member States.

Disease in animals

Disease in animals is inevitable on farms, no matter how good the husbandry. In terms of food safety, one option for control would be to eradicate specific agents if they are identified on the farm. This, however, depends first on being able to identify the agent in the herd or flock. In addition to there being an accurate 'test' available, there is the need to decide if eradication is really necessary, for animal health and human health reasons, or for both. The biological way forward of disease control using vaccines promises to be an important alternative to the need for use of antibiotics. While it has always been important to use available vaccines in the appropriate manner, with the increasing efficacy, and at the same time specificity, of modern vaccines, precise diagnosis becomes a must. There is, therefore, a future for the veterinary clinician on the farm as a means by which there can be improvements to the health status of the food production animals following proper assessment of all relevant factors including the provision of a farm veterinary health plan. The success of any scheme for any farm or unit requires, as a minimum: (i) surveillance of possible diseases or risks; (ii) management structure in place to avoid the need to react; (iii) active supervision at all levels, and (iii) investigation of all possible, or actual, problems or variations from the normal.

Of all the foods produced on UK farms, milk has for many years been a good example of what can be achieved in terms of consumer health protection by a combination of legislative control with financial incentive, or penalty, according to the quality of the milk produced. This has now been extended by producer schemes from the milk companies and major retailers which include routine audits of all aspects of on farm production. Milk in the UK is produced from cows, sheep and goats, although there is provision in the legislation for the production of buffalo milk. Although the presence of some bacteria in milk is inevitable, either directly from the udder or by contamination during milking, the systems currently in use aim to minimise the possibility of contamination during the milking process. One of the more clearly defined parts of the farming operation to which the HACCP concept can be applied is in the production of milk. Over the years, the critical points in milking have been clearly identified and the working practices necessary to ensure clean milk production established. A major problem in the dairy industry is mastitis, either clinical or subclinical. Mastitis-causing organisms can broadly be divided into contagious bacteria and environmental bacteria as shown in Table 1. Contagious bacteria are predominantly associated with the cow's udder and tend to be spread from cow to cow during milking. Environmental organisms are always present in the discharges from the alimentary or reproductive tracts and survive and multiply in the bedding[8].

Table 1 Organisms commonly causing mastitis

Contagious bacteria	*Streptococcus agalactiae* *Streptococcus dysgalactiae* *Staphylococcus aureus*
Environmental bacteria	*Escherichia coli* *Coliforms* *Streptococcus uberis* *Corynebacterium pyrogenes*

Other organisms such as *Listeria monocytogenes*[9], *Streptococcus zooepidemicus*[10], *Salmonella typhimurium* DT 104[11] and 49a[12] and *Salmonella enteritidis*[13] have, on rare occasions, been attributed to cases of mastitis. While most cases of mastitis in sheep are caused by Gram-positive cocci[14], a proportion of cases are due to Gram-negative bacteria, predominantly *Pasteurella haemolytica*[15], with occasional cases due to *Pseudomonas aeruginosa*[16]. While Gram-positive organisms are found in goat's milk, bacteriological problems are related to poor hygiene during production. In all species it is also possible to find Q fever (*Coxiella burnetti*) and *Brucella* organisms in the milk. Mastitis is usually divided, on the basis of clinical signs, into three broad categories. Acute mastitis is sudden in onset and tends to be severe, and chronic mastitis causes a considerable loss of milk forming tissue – both are easily recognisable by the farmer. Subclinical mastitis, which is not detected by the usual visual signs, is detected by an increase in the somatic cell count (SCC). The somatic cell count in milk is the measurement most commonly used as an indicator of udder health. Normal milk has a SCC of less than 200,000/ml and elevation is an indication of inflammation of the udder. To encourage good hygienic milk production and good udder health, the price paid for cows' milk varies with the SCC and the total bacterial count (TBC) and there is a financial penalty for elevated counts. In addition, there is a maximum of 400,000/ml for SCC, set by the EU, for milk. The TBC has now been replaced by the Bactoscan which is said to provide a better measure of bacterial loading of a milk sample as it takes account of both live and dead bacterial cells. The intramammary route for the administration of antimicrobial drugs is a convenient route for treating infections of the quarter of the udder affected and for the administration of long-acting preparations at the end of the lactation. Dry cow therapy is designed to remove infections present then in the udder and to prevent new infections during the dry period. The udder is naturally resistant to Gram-negative organisms but, in addition to specially targeting *Staph. aureus* and *Strep. uberis*, the preparation should be effective against any *E. coli* present in the udder.

Table 2 Food poisoning organisms associated with meat dishes

Clostridium perfringens
Salmonellae
Verotoxigenic Escherichia coli
Campylobacter
Yersinia enterocolitica
Listeria monocytogenes
Aeromonas hydrophilia
Staphylococcus aureus

Meat can be contaminated with a large variety of pathogens and spoilage bacteria. The organisms associated with the majority of food poisoning associated with meat dishes[17] are given in Table 2. These organisms can be found in the alimentary tract of healthy animals and in the case of *E. coli* O157, while it has prevalence in the ruminant of at least 10% with a seasonal variation in excretion rates[18], it is not a recognised cause of disease in animals.

Meat, in the unskinned and uneviscerated healthy animal or bird, can be regarded as sterile[19]. The removal of the outer coat and the act of evisceration are points in the slaughter of animals when contamination can occur. The exception is when there is an invasive organism, such as *Salmonella,* in some organ or lymph node. A major control point is the conversion of the live animal to meat in a hygienic manner by the careful removal of the outer coat and the entire alimentary tract without contamination or spillage of gut contents. Live poultry carry large numbers of many different micro-organisms on the skin, among feathers as well as in the alimentary tract. When birds are being transferred from the farm to the processing plant there is an increase in shedding and spread of faecal material with an increase in *E. coli* on the breast surface. During processing, a high percentage of the organisms will be removed but the very nature of poultry processing, where the birds are passed through a scalding tank before defeathering, leads to cross contamination. The changes in the skin from the scald process also favour entrapment of bacteria. In order to reduce the risk of gut rupture during evisceration, the feed is removed a number of hours before transport. This practice also reduces the excretion rate of *Salmonella* by the birds arriving at the slaughter plant. However, recent work has shown that fasting prior to transport may lead to an increase in the *Salmonella* levels in the crop, an organ also likely to burst during mechanical evisceration[20]. Current slaughter practice keeps the carcass whole, which makes evisceration without rupture of the viscera more difficult.

One of the food safety controls for many has been *post mortem* inspection of meat in the abattoir. The use of a physical meat inspection in slaughter animals has been questioned with good evidence that there is increased spread of zoonotic organisms by the actions carried out during the meat inspection process. Pathogenic bacteria, such as *Salmonella* and *Campylobacter* species, can be present in the lymph nodes, digestive tracts and on the surface of symptomless carrier animals[21] and have been shown to be spread by actions of the meat inspection team. Gross lesions such as parasitic cysts and kidney conditions can be missed by current inspection techniques[22–24] especially in high-throughput abattoirs[25]. Traditional meat inspection will not reveal the presence of zoonotic agents such as *Salmonella*, *Campylobacter* and *Yersinia* species, *Trichinella spiralis* and *Toxoplasma gondii*[23,26,27].

Production and health information from the poultry unit has been used for a number of years to target the level of *post mortem* meat inspection necessary for each batch of broilers delivered to the slaughter plant. There is a strong possibility that all inspection systems will change to one based on an analysis of risk. An important part of any new system will be the monitoring of salmonella on the farms of origin. Studies of the type by Edwards *et al*[28] and Fries *et al*[29] are required to provide the basis for any alternative system of integrated meat inspection. Such studies might give the background for designing a truly targeted organoleptic *post mortem* inspection system that yields a net benefit to consumer health protection.

One of the big food scares followed the announcement by Edwina Currie in 1989 about *Salmonella* in eggs. There then followed a dramatic drop in egg sales. A whole raft of measures were put in place by Government to control *S. enteritidis* and *S. typhimurium*, which included slaughter arrangements for infected flocks. The recommendations contained in the Richmond Committee Report[1] dealt specifically with poultry industry and made a number of recommendations relating to housing, husbandry and animal feed. A code of practice was published by MAFF in 1996 which provides guidance on good hygiene principles and practice on the production site, at the grading and packing station and during distribution and storage. The British Egg Industry Council operates a Code of Practice for Lion Quality eggs. This has been revised to include a requirement by the flocks to use vaccination for *S. enteritidis*. These measures collectively appear to be reducing the incidence of *S. enteritidis* in the laying flocks in the UK.

Future assurance to consumers

A cornerstone of future assurance to consumers, the EU and the rest of the world will be that proper supervision and checks are being carried out on the farm with adequate records being maintained. To provide this assurance, the aim must be a minimum of 100% compliance with current legislation with evidence available that this level of compliance is being maintained. There has been, in recent years, an increase in the number of farm assured schemes and the direct influence by the major retailers on agricultural practices through their producer schemes. These farm quality assurance programs stress the importance of a strong working relationship between producers and their veterinarians and emphasise that efficient management practices are a way on the farm of improving the safety of the food supply. One major problem is that when HACCP is said to be used it is usually as part of the farm Quality Assurance scheme when in reality it is frequently 'safety' equals 'welfare' and there is little consideration of true food safety issues. There is a real need for the whole area to be properly established so that any HACCP or risk assessment/management approach is set up to **manage** and not to **react**.

The reputation of the stakeholders – the farming industry, and the professions must not be compromised in any way, for whatever reason. However, the consumer must recognise that there is a cost to all the improvements to the on-farm situation in the UK. The same high standards must also apply to foods of animal origin imported from countries where the controls, both food safety and welfare, will not be as rigorous as in the UK and reflected in the lower cost of the product.

The role of food from non-traditional species must also be considered in the future. World supplies of animal derived protein are limited and, in some parts of the world, under considerable pressure. It is possible to harvest more from the wild, provided care is taken while drawing on wild life reserves. Already game farming and fish farming, in particular, have changed the availability of different types of meat.

Often the concerns about the whole food-chain are associated with food scares and presented as a perceived worry about food-related issues that has little, if anything, to do with reason for the food scare. On the other hand, if the controls placed on the industry are so stringent, there will be such an increase in cost of production that the result will be increased imports of produce from countries where the standards of husbandry and slaughter are less than here in the UK.

It is also most important, when considering the need for legislation, to recognise the differences between disease in respect of animal health or human health. At present, there are, however, no specific statutory food safety controls applicable to on-farm production. It is very easy to say that more control is necessary on the farm, and even increase the legislative controls on farming; however, legislation is not always the answer, especially if there is no audit of compliance. Equally, in the EU and world-wide market place, there is little point in disadvantaging UK agriculture such that it is priced out of the market and the food is imported from farming systems of lesser standards both in terms of welfare and of food safety, but cheaper. An example could be the banning of sow stalls, on welfare grounds, in the UK, with a significant extra cost on the UK pig producer, which has not been applied to any other country. Equally of concern at this time are the increasing reports of animal medicines available illegally, even by mail order, with suggestions that they are 'on the internet'. They must be very tempting to farmers at this time of economic crisis in farming, not least when they are advertised at less cost than the veterinary surgeon can purchase the same drug.

The food-producing industry has increasingly become a target for consumers campaigning for changes in animal welfare and husbandry systems, as well as their expressions of concern for the environment. These concerns about the food animal production systems and the methods by which the product is harvested, including how animals and birds are slaughtered to produce meat, are very relevant to the whole subject of veterinary public health.

It is often forgotten that farming is a commercial enterprise but one which involves animals. As such, it should be an efficient operation producing clean food, to be consumed directly or incorporated in other foodstuffs, with the highest standards of animal husbandry, yet making a reasonable return on the farmer's investment.

References

1 Committee on the Safety of Food (Chairman Sir Mark Richmond). *The Microbiological Safety of Food*, Part I. London: HMSO, 1990; 45–58

2 Ministry of Agriculture Fisheries and Food. *The Report of the Expert Group on Animal Feedingstuffs* (The Lamming Report). London: HMSO 1992; 2

3 Johnston AM. *Bovine Spongiform Encephalopathy*. CPD Veterinary Medicine, vol 1. London: Rila Publications, 1998; 26–9

4 Opinion of the Scientific Committee on Veterinary Measures Relating to Public Health. *Assessment of potential risks to human health from hormone residues in bovine meat and meat products*. Brussels: European Commission, 30 April 1999 [also on www.europa.eu.int/comm/dg24/health/sc/scv/outcome_en.html]

5 *Report of the Joint Committee on the Use of Antibiotics in Animal Husbandry and Veterinary Medicine*. Chairman Professor M Swann. London: HMSO, 1969

6 *Advisory Committee on the Microbiological Safety of Food. Report on Microbial Antibiotic Resistance in Relation to Food Safety*. London: The Stationery Office, 1999

7 *Opinion of the Scientific Steering Committee on Antimicrobial Resistance*. Brussels: European Commission Directorate-General XXIV,, 28 May 1999 [also on www.europa.eu.int/comm/dg24/health/sc/ssc/outcome_en.html]

8 Berry EA. Mastitis incidence in straw yards and cubicles. *Vet Rec* 1998; 142: 517–8

9 Sharp MW. Bovine mastitis and *Listeria monocytogenes*. *Vet Rec* 1989;.125: 512–3

10 Edwards AT, Roulson M, Ironside MJ. A milkborne outbreak of serious infection due to *Streptococcus zooepidemicus* (Lancefield group C) *Epidemiol Infect* 1988; 101. 43–51

11 Sharp MW, Rawson BC. Persistent *Salmonella typhimurium* DT 104 infection in a dairy herd. *Vet Rec* 1992; 131 375–6

12 Giles N, Hopper, SA, Wray C Persistence of *S. typhimurium* in a large dairy herd. *Epidemiol Infect* 1989; 103: 235

13 Wood J, Chalmers G, Fenton R *et al.* *Salmonella enteritidis* from the udder of a cow. *Can Vet J* 1989; 30: 833
14 Watson DL, Franklin NA, Davies B *et al.* Survey of intramammary infections in ewes on the New England Tableland of New South Wales *Aust Vet J* 1990; 67: 6–8
15 Jones JET Mastitis in sheep. In: Owen JR, Axford RFE (Eds) *Breeding for Disease Resistance in Farm Animals*. Wallingford: CAB International 1991; 412–23
16 Las Heras A, Dominguez L, Lopez M *et al.* Outbreak of acute ovine mastitis associated with *Pseudomonas aeruginosa* infection. *Vet Rec* 1999; 145: 111–2
17 Foegeding PM, Roberts T, Bennett JM *et al.* *Foodborne Pathogens: Risks and Consequences*, Task Force Report no 122 Ames, Iowa: Council for Agricultural Science and Technology (CAST) 1994
18 Chapman PA, Siddons CA, Wright DJ *et al.* Cattle as a source of verocytotoxin-producing *Escherichia coli* O157 infections in man. *Epidemiol Infect* 1993; 111: 439–47
19 Gill CO. Intrinsic bacteria in meat. *J Appl Bacteriol* 1976; 47 367–78
20 Corrier DE, Byrd BM, Hargis ME *et al.* Presence of *Salmonella* in crop and caeca of broiler chickens before and after preslaughter feed withdrawal. *Poult Sci* 1999; 78: 45–9
21 Peel B, Simmons GC. Factors in the spread of *Salmonella* in the meatworks with special reference to contamination of knives. *Aust Vet J* 1978, 54, 106–10
22 Samuel JL, O'Boyle DA, Mathers WJ, Frost AJ. Isolation of salmonella from mesenteric lymph nodes of healthy cattle at slaughter. *Res Vet Sci* 1979; 28: 238–41
23 Hathaway SC, McKenzie AI. Postmortem meat inspection programs, separating science and tradition *J Food Protect* 1991; 54: 471–5
24 Berends BR, Snijders JMA, van Logtestijn JG. Efficacy of current meat inspection procedures and some proposed revisions with respect to microbiological safety a critical review. *Vet Rec* 1993; 133: 411–5
25 Madie P. Do we still need meat inspection? *Vet Cont Ed* 1992; 145: 7–85
26 Hathaway S, McKenzie I, Royal WA. Cost effective meat inspection programs; separating science and tradition. *J Food Protect* 1987; 120, 78
27 Hathaway SC, Pullen MM, McKenzie AI. A model for risk assessment of organoleptic post mortem meat inspection procedures for meat and poutry *J Am Vet Med Assoc* 1988; **192**: 960–6
28 Edwards DS, Christiansen KH, Johnston AM, Mead GC. Determination of farm-level risk factors for abnormalities observed during post mortem meat inspection of lambs: a feasibility study. *Epidemiol Infect* 1999; 123: 109–19
29 Fries R, Bandick A, Dahms S, Kobe A, Sommerer M, Weiss H. *Field experiments with a meat inspection system for fattening pigs in Germany*. World Congress on Food Hygiene, August 29th 1997, Den Haag, The Netherlands, 9–14