

EXAMPLES OF HAZARDS IN FEED WITH POTENTIAL RELEVANCE FOR HUMAN HEALTH

1. This Annex is not a comprehensive description of the different situations related to feed and food safety. The information included in this Annex may need to be updated as more scientific knowledge becomes available on these issues. By illustrating hazards which may occur in different parts of the world, this Annex is intended to provide additional information on how to use the prioritization procedure in practice as described in the guidance. Therefore, this Annex should not be taken as a risk assessment of the cases mentioned.
2. This Annex should be considered in conjunction with the report of the FAO/WHO Expert Meeting on Animal Feed Impact on Food Safety (FAO/WHO, Rome, 2008) when making the initial step of the prioritization process.
3. The examples may not be relevant everywhere or at all times; they simply illustrate the range of hazards, feeds and edible products which may need to be considered in a given location at a given time. In addition, rare and emerging hazards are not covered.
4. The following examples are listed according to the types of hazards.

Biological hazards

Bacteria

5. The primary microbiological hazards in feed that can transfer to edible products of food-producing animals are zoonotic microorganisms contaminating feeds. These microorganisms may be introduced into feed by, for example, crops, forages and water from contaminated pasture land or cross-contamination from infected animals (including carcasses) during feed production, processing, transport, storage and use.
6. *Salmonella* is a worldwide human health concern. Contaminated feed can represent a route of exposure of food-producing animals to *Salmonella*. Edible products affected can include eggs, meat and meat products. However, the correlation between contaminated feed and infection by a given *Salmonella* strain and the contamination of edible products from these animals needs to be established on a case-by-case basis. Adequate strain typing is necessary to establish such correlations. Strain typing is also important to identify strain types that are more commonly associated with human pathogenicity. In the absence of the establishment of such correlation or of strain typing, any contamination of feed with *Salmonella* could be considered as a hazard, particularly if not adequately heat-treated prior to its use.
7. *Brucella*: In countries where *Brucella* is endemic, pasture may be contaminated by ruminants which deliver or abort offspring there, because the placentas of infected animals contain high levels of these microorganisms. Milk-producing animals may become infected by eating forage from contaminated pastures and excrete the microorganisms in their milk. This milk may be a risk to human health if not pasteurized prior to use.

Endoparasites

8. Some animal endoparasites, such as *Toxoplasma* and *Taenia* spp., are human health hazards. Various life stages of these organisms may contaminate pasture and forages and the derived feed via infected animals. Ingestion of contaminated feed by food-producing animals can result in the presence of infective cysts in edible products (e.g. meat), which may pose a risk to human health, particularly if not adequately heat treated prior to consumption.

Prions

9. Prions are infectious agents composed of protein in a misfolded form which induces existing, properly-folded prion protein (PrP^c, a constituent of normal mammalian cells) to convert into the disease-associated, prion form (PrP^{Sc}). Prions are responsible for the transmissible spongiform encephalopathies in a variety of mammals, including bovine spongiform encephalopathy in cattle and variant Creutzfeldt–Jakob disease in humans. Prions are extremely resistant to denaturation by chemical and physical agents including heat. Exposure of food-producing animals can occur via feed contaminated with material from prion-infected carcasses. Transfer from prion-contaminated feed to edible products has been demonstrated.

Chemical hazards

Elements

10. A number of elements may present a hazard to humans. This includes radionuclides and elements commonly referred to as "heavy metals", such as arsenic, cadmium, lead and mercury.

11. Radionuclides including caesium-134, caesium-137, strontium-90 and iodine-131 present in animal feed and forages may transfer to edible products. Major sources are contaminated soil, water and forage. Transfer of radioiodine to milk, radiostrontium to bone, and radiocesium to milk, eggs and meat has been demonstrated.

12. The following are non-exhaustive examples of “heavy metals”:

- Arsenic is a naturally-occurring contaminant found in minerals and (mainly in the less toxic organic form) in marine plants, fish and shellfish and other farmed aquatic animals.
- Cadmium is a naturally-occurring contaminant in soil minerals (such as phosphate and zinc sources), and in forages and cereals grown near smelting and mining areas, or where the soil has been treated with contaminated manure, sewage, sludge or phosphate fertilizers; edible products affected include shellfish, oysters, salmon, also kidney and liver.
- Lead contamination may occur naturally or from industrial waste in, for example, feed minerals (e.g. copper sulphate, zinc sulphate, zinc oxide) and in forages and cereal via air, soil or water contamination; it is found in edible products such as fish, milk, bone, brain and kidney.
- Mercury from industrial sources, which contaminates soil and water can produce secondary contamination of forages, crops and aquatic organisms; edible products affected have included liver, kidney, fish, and other aquatic animals.

Toxins

13. Toxins are naturally occurring hazards that include:

- Mycotoxins, e.g. aflatoxins, ochratoxins, zearalenone;
- Bacterial toxins, e.g. botulinum toxin and staphylococcal enterotoxin;
- Terrestrial plant toxins, e.g. solanine in potatoes, gossypol in cottonseed;
- Marine toxins, e.g. toxins from certain algae, particularly dinoflagellates.

Mycotoxins

14. Mycotoxins are produced by fungi commonly found in cereals (especially wheat, sorghum and maize), oilseed meals and cakes, and silage.

15. Transfer from feed to edible products has been demonstrated for various mycotoxins including aflatoxins and ochratoxins.

16. Aflatoxins can occur in e.g. copra, peanut cake, sunflower cakes, corn, corn gluten, rice bran, cottonseed, palm kernel and soy beans. Aflatoxin B₁ is metabolized in some food-producing animals to aflatoxin M₁ which transfers to milk. Aflatoxin M₁ is a human carcinogen.

17. Ochratoxin A is most commonly found in cereals such as rye, barley, maize and wheat, and to a lesser extent in peanuts and soybeans. It transfers to edible products such as blood, liver and kidney and to a lesser extent meat, fat and milk. Ochratoxin A is nephrotoxic in humans.

18. Fumonisin, deoxynivalenol, T-2 and HT-2 toxin and zearalenone are rapidly metabolized and/or excreted by food-producing animals and are therefore not major contaminants of edible products.

Bacterial toxins

19. A limited number of toxins produced by bacteria such as *Clostridium botulinum*, *C. tetani* and *C. perfringens*, *Vibrio cholerae*, *Staphylococcus aureus*, *Yersinia enterocolitica*, and *Shigella dysenteriae* are acutely toxic to food-producing animals when ingested with feed but transfer of toxin to edible products is unlikely.

Terrestrial plant toxins

20. Toxin-producing plants may occur in grasslands used for forage. Naturally occurring toxins can include pyrrolizidine alkaloids (e.g. *jacoline* from *Senecio jacobaea*) and other alkaloids (e.g. atropine, cocaine, ephedrine, morphine, nicotine, solanine), terpenes (e.g. camphor, pinene), tetrahydrocannabinol, gossypol, isoflavones, and glycosides (e.g. cyanogenic glycosides, digitalis). Transfer of some of these toxins to edible products such as milk and meat has been demonstrated.

Marine toxins

21. Dinoflagellates such as *Gambierdiscus toxicus* in tropical and subtropical waters produce marine toxins including heat-resistant ciguatoxin, maitotoxin, scaritoxin and palytoxin. Small filter-feeding fish which

can accumulate such biotoxins and their predators may be harvested and used to make fish meal. Transfer of ciguatera toxin to human milk after maternal poisoning has been reported, so transfer from feed to milk of food-producing animals is a possibility.

Organic chemicals

22. Of the many organic chemical contaminants that are present in the environment and therefore are potentially present in feed, it is the lipophilic compounds that have the greatest tendency to accumulate in edible products of food-producing animals.

23. Polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) commonly known as dioxins, and organochlorine pesticides such as aldrin, dieldrin, and dichlorodiphenyltrichloroethane (DDT), are lipophilic and have long half-lives in the environment. Dioxins in feed may arise by contamination, for example from dioxin-containing preservatives in wood, or from combustion sources (e.g. waste incineration plants, fossil fuel power stations, bush fires, exhaust gases) or by chemical reactions during processing involving solvents containing chlorine. Dioxins may be present as contaminants in mineral sources, such as clays, recuperated copper sulphate, zinc oxide, and in food by-products, including fish by-products such as fish meal and fish oils. Dioxin contamination of edible products has been reported for fish, fat of meat, milk, and egg yolk.

24. Polychlorinated biphenyls (PCBs) have been widely used in a number of industrial and commercial applications. Although the manufacture, processing and distribution of PCBs have been prohibited in almost all industrial countries since the 1980s, their entry into the environment still occurs. Following exposure of farmed animals, including aquaculture, PCBs will accumulate in meat, liver and particularly in fat tissues. PCBs have been reported to be associated with an increased risk of cancer of the digestive system and possibly other sites.

Pesticides, veterinary drugs, feed additives and processing aids

25. Cross-contamination of feed by pesticides, veterinary drugs, medicated feed, feed additives and processing aids may occur during production, processing, transport or storage.

26. Unapproved use of pesticides, veterinary drugs, medicated feed, feed additives and processing aids, or the presence of undesirable substances, may lead to excessive levels in feed and edible products (e.g. clenbuterol in meat).