E. HANAK, E. BOUTRIF, P. FABRE, M. PINEIRO, (Scientific Editors), 2002. Food Safety Management in Developing Countries. Proceedings of the International Workshop, CIRAD-FAO, 11-13 December 2000, Montpellier, France, CIRAD-FAO. CIRAD CD-ROM, Montpellier, France.

Risks of Undesired Substances in Feeds and Animal Food Products [1]

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Abstract

Meat and other animal food products meet specific nutritional needs that may not be as well served by diets consisting mainly or wholly of plant origin food. However, animal feed or forage could be the source of infections or intoxication for farm animals that can reduce efficiency in production, cause poor feed utilization and ultimately lead to human illness. This article reviews the major sources of microbial and chemical contamination of animal products through feed, and argues for the need for the establishment of strong regulatory programs developed from well thought-out food and feed quality and safety control strategies. It reviews the major standards, codes and guidelines that have been established by the Codex Alimentarius Commission to protect the health and economic interest of consumers and to facilitate international trade in feedstuffs and animal products. Guidelines are now in the process of being developed specifically for animal feeding, by the new Codex Ad hoc Intergovernmental Task Force on Animal Feeding established in July 1999.

Introduction

The livestock sector plays an essential role in food production and food security. The contribution of livestock goes far beyond direct food production (meat, milk, eggs and other animal products) and includes many uses, such as draft power (contributing to crop production, transportation...), feed ingredients, skins, fiber, fertilizer and fuel, as well as capital accumulation. In the developing world, livestock production is closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability.

Animal products are a primary source of proteins, amino acids and fats, and when they are a major constituent of diets they contribute a significant proportion of total calories. They are, however, highly perishable products which require special attention to prevent their deterioration and/or contamination by various agents, biological as well as chemical. Some of these contaminants can be transmitted by the feed.

[1] This FAO paper is an up-dated version of an FAO presentation made at the May 1997 European Renderers' Association (EURA) Annual Congress, Copenhagen.

Feed Contaminants - Potential Problems

Concern about food contamination has led to a number of actions that can have a significant impact on food trade and on health. In recent years public concern regarding food safety has increased, as a consequence of the increasing prevalence of *Salmonella enteritidis* in eggs, poultry and other meat products, localized outbreaks of illness associated *with Listeria monocytogenes* in dairy products and paté and *Escherichia coli 0157:H7* in ground or minced beef, and the appearance of problems such as Bovine Spongiform Encephalopathy (BSE) in cattle and new emerging pathogens. The general heightening of interest internationally has prompted food control authorities and the food industry in many countries to strengthen the control measures for these infectious agents and for other contaminants in animal feed.

For food derived from animal sources, contamination may originate from a number of sources including the consumption by the animals of contaminated feed. Examples of food risks that may relate to animal feedstuffs are given below:

Salmonellae

Salmonellae are widely distributed in nature, and animal feed is only one of many sources for farm animals. Animal and plant origin feed ingredients are frequently contaminated with *Salmonellae*. Processed feed can be contaminated from these raw feed ingredients.

There are over 2000 salmonella serotypes and these can be divided arbitrarily into three unequally sized groups. These include the species-specific serotypes such as *S. dublin* (cattle); the invasive serotypes which may cause septicemia disease in several animal species (e.g. *S. enteritidis* and *S. typhimurium*); and the non-invasive serotypes which tend not to result in septicemia. Members of the first group are not recognized as food-borne pathogens. The third group is by far the largest and may be associated with sub-clinical infections in farm livestock. They can cause disease on occasion and are associated with food poisoning in humans. The principal manifestation of human *salmonellosis* is a gastroenteritis. Septicemia occurs in a proportion of patients.

Toxoplasma gondii

This protozoan is found in cats as well as birds and other domesticated species including sheep, pigs, goats, and horses. The primary source of infection for animals is feedstuffs contaminated with feces of cats and possibly rodent tissues. A proportion of humans may become infected following the handling or consumption of contaminated raw meat.

Trichinella spiralis

This is a nematode which parasites the intestinal tract of mammals, particularly pigs. The larvae encyst in the tissues, particularly the muscles which act as a source of infection for humans who consume raw or partially cooked meat. The clinical manifestations include fever, muscle pain, encephalitis, meningitis, myocarditis and rarely death.

The cysts can be killed by freezing infected carcasses at -18 degrees C for 20 days. They are also heat sensitive and are killed by traditional rendering temperatures. Effective cooking of raw meat and table scraps before feeding to farm animals would eliminate this hazard.

Mycotoxins

Mycotoxins are metabolites produced by fungi of various genera when they grow on agricultural products before or after harvest or during transportation or storage. Mycotoxins are regularly found in animal feed ingredients such as maize, sorghum grain, rice meal, cottonseed meal, groundnuts and legumes, wheat, barley and others. Most are relatively stable compounds and are not destroyed by processing of feed and may even be concentrated in screenings. Some fungi such as *Aspergillus spp*. and *Penicillium spp*. can invade grain after harvest and produce mycotoxins, while others, such as *Fusarium spp*., typically infest grains and produce mycotoxins before harvest. In some circumstances *Aspergillus ssp.* can grow and produce mycotoxins before the crop is harvested.

Both intrinsic and extrinsic factors influence fungal growth and mycotoxin production. The intrinsic factors include moisture content and acidity, whereas extrinsic factors include relative humidity, temperature and availability of oxygen.

There is presently only limited information available regarding the occurrence of mycotoxin residues in animal products intended for human consumption. It is known that milk cows can convert Aflatoxin B_1 into Aflatoxin M_1, which is found in milk. This has caused considerable trade problems when Aflatoxin M_1 is found in milk, and concern about the safety of such milk. Further research is needed to study the metabolism of mycotoxins by animals and the residues of mycotoxins and/or their metabolites in animal tissues. However, in many instances the problems of mycotoxins in feeds have more direct effects in that they can kill or create illness in young animals and prevent efficient growth or feed utilization.

Veterinary Drugs

These medications may be administered in animal feeds. If the concentration used results in foods of animal origin with residues exceeding the Codex maximum residues limit (MRL), there may be a potential hazard to human health. Codex MRLs should not be exceeded if concentrations used are correct and withholding times are observed.

Agricultural and Other Chemicals

Potential contaminants include excessive residues of herbicides, pesticides and fungicides, or other contaminants such as the polychlorinated biphenyls (PCBs) and heavy metals including mercury, lead, or cadmium.

Transmissible Spongiform Encephalopathies (TSEs)

These appear in ruminants as non-febrile neurological diseases. They have a long incubation period and are ultimately fatal. TSEs are associated with incompletely defined agents, currently termed prions, which are resistant to normal heat treatment of feed and food. Sheep scrapie has been known for over 250 years, while Bovine Spongiform Encephalopathy (BSE) was first recognized in the United Kingdom in 1986. For BSE it has been postulated that the etiological agent enters the feed primarily through rendered infected tissues (notably the tissue of the central nervous system and the reticuloendothelial system) under conditions of insufficient heat treatment to destroy or inactivate the infectious agent. The reported occurrence of a new variant of the human TSE, Creutzfeldt-Jacob Disease (CJD), has raised the possibility of an association with BSE in cattle with CJD in humans through consumption of meat from BSE-infected cattle.

Control of Feed Problems

Over many years the feeding of animals and the preparation of feed ingredients has not received adequate quality and safety attention. Complacency among feed regulatory officials and the animal feed, husbandry, and products industries have led to many preventable problems with feed ingredients and ready-to-use feeds, and to contaminated animal products reaching the market. The recent *Salmonellae*, *E. coli* and BSE problems mentioned above have brought about demands that feed contamination, animal husbandry and animal products processing problems be resolved as soon as possible.

In order to determine how to better address the problems of feed ingredients and contaminated feed, FAO organized in March 1997 an Expert Consultation on Animal Feeding and Food Safety. The primary purpose of this Expert Consultation was to discuss current animal feed problems, and to develop a draft Code of Practice for Good Animal Feeding for consideration by the Codex Alimentarius Commission, as advice to FAO member countries. This draft Code covers good animal feeding practices, and adherence to Good Manufacturing Practices (GMPs) in the procurement, handling, manufacturing, storage and distribution of commercially-produced feeds for food-producing animals. It provides guidance on the general management of production processes, pre-production ingredients handling and post-production storage and distribution practices. The draft Code is now under consideration by the Codex Intergovernmental ad hoc Task Force on Animal Feeding, established in July 1999.

Legislative measures should be prepared which permit the application of food and feed standards. These standards should be enforced through adequately equipped and trained staff performing inspection and laboratory functions in accordance with compliance programs developed from a well thought-out food and feed quality and safety control strategy.

International Standards, Codes and Advice

Many countries need to improve their levels of control of food and feed. While basic responsibility rests with the food producers, processors, marketers and national governments, international agencies have been providing advice and assistance in these areas for many years. The Codex Alimentarius Commission (CAC) which was established in 1962 to implement the Joint FAO/WHO Food Standards program has, since its creation, developed a number of Codex standards, guidelines and recommendations which include provisions relating to the quality and safety of animal feeds and food of animal origin. These include:

Preamble to the Codex General Standard for Contaminants and Toxins in Food (Codex Stan 193-1995 - Volume 1A, Section 6.1)
This standard contains the main principles and procedures used and recommended by the Codex Alimentarius in dealing with contaminants and toxins in food and feeds. It lists the maximum levels of contaminants and natural toxicants in food and feeds recommended by the CAC to be applied to commodities moving in international trade.

List of Codex Maximum Residue Limits for Pesticides and Codex Extraneous Maximum Residue Limits (EMRLs) (General Text, Volume 2A and MRLs, Volume 2B)
This text provides the basis for establishing the Codex MRLs and EMRLs, the consideration given to human daily intake and explanatory notes on how to view and interpret the data, describing the meaning of various symbols used. A list of the commodities and Codex MRLs/EMRLs is provided.

List of Codex Maximum Residue Limits for Veterinary Drugs (Volume 3-1994)
The Codex MRLs for Veterinary Drugs are provided and are consistent with the recommendations of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), a body of independent scientists who serve in their individual capacity as experts and evaluate veterinary drugs to establish safe levels of intake and develop maximum residue levels when veterinary drugs are used in accordance with good veterinary practices.

Recommended International Code of Practice for Control of the Use of Veterinary Drugs (CAC/RCP 38-1993, Volume 3-1994)
This code sets out guidelines on the prescriptions, application, distribution and control of drugs used for treating animals, processing animal health and improving animal production. It includes Good Practices in the Use of Veterinary Drugs (GPVD), including premixes for the manufacture of medicated feedstuffs.

Codex Standards for Processed Meat and Poultry Products (Part 1, Volume 10-1994)
A number of food standards have been elaborated by Codex with quality and safety requirements. They include standards for corned beef, luncheon meat, cooked cured ham, cooked cured pork shoulder and cooked cured chopped meat.

Codes of Practices and Guidelines for Processed Meat and Poultry Products (Part 2 and Part 3, Volume 10 - 1994)
Codex has elaborated recommendations and guidelines related to hygienic protection for processed meat and poultry products; poultry processing; production, storage and composition of mechanically separated meat and poultry meat intended for further processing; hygienic practice for fresh meat and game; a code for ante-mortem and post-mortem judgment of slaughter animals and meat.

Conclusion

Livestock are important contributors to total food production. Meat and other animal food products meet specific nutritional needs that may not be as well served by diets consisting mainly or wholly of plant origin food.

Food will always represent some minimal biological risk and it is the task of the food and feed industry to maintain the level of risk from feeds and animal origin food products at the lowest possible level by applying practical and technologically feasible measures to prevent hazards. Regulatory bodies should use risk assessment to determine acceptable, realistic and achievable risk levels to manage food-borne hazards. Their risk management and food safety policies should assure feed quality and safety to prevent animal food production contamination.

Food safety is the shared responsibility of governments, academia, the food and feed industry and the consumer. Regulatory programs should be established which ensure that foods of animal origin produced for human consumption are both safe and wholesome. Food-borne illnesses are preventable. Adherence to good manufacturing practices and good hygienic practices and application of quality and safety management systems, including HACCP, at the feed production and farm level, are essential to achieve food safety and ensure food quality.

Codex standards, codes and guidelines have been established to protect the health and economic interest of consumers. The standards are based on scientific principles, and incorporate the principles of risk analysis and process control. There are designed to permit flexibility in the method of achieving the specified quality standard, so that procedures and

approaches may be adopted that are appropriate to a range of production and processing methods.