

Biological Hazards in Meat and Poultry

1) Examples

Potential biological hazards in meat and poultry include bacteria, toxins, viruses, protozoa, and parasites. Of the biological hazards, the most important are bacteria which can cause either food borne infections or intoxications. Bacteria cause a large proportion (approximately 90%) of all food borne illnesses. Bacteria that cause human illness, including disease, are termed pathogenic. Most food borne illness can result in diarrhea, nausea, vomiting, stomach cramping, and in more serious cases, organ damage, stillborn births, and death.

The pathogens that are most likely to be found in commonly slaughtered livestock (cattle, sheep, and swine) and poultry (chicken and turkey) include *Salmonella*, *Campylobacter*, and *Listeria monocytogenes*. In addition, *Yersinia enterocolitica* has been isolated from swine as well as being detected in the environment. *Listeria monocytogenes* also is widespread in the environment and is often present in soil, water, and silage. Although *Escherichia coli* also is found in livestock and poultry, most forms of *Escherichia coli* are not pathogenic. *Escherichia coli* O157:H7 is pathogenic. The ultimate source for all of these pathogens is apparently healthy animals that may shed these bacteria in their feces. While dressing the carcasses during the slaughter process, these bacteria may be transferred from the hide and offal to the carcass causing contamination. All of these pathogens have been implicated in widely publicized food borne disease outbreaks associated with the consumption of meat and poultry products. In the production of the not shelf stable (NSS) NRTE/RTE products pathogenic bacteria and zoonotic agents should be considered while conducting the hazard analysis. Proper cooking, fermentation, cooling, and storage of food can destroy and/or prevent growth of these bacteria. Zoonotic agents are biological hazards that cause disease in animals which can be transmitted to and cause disease in humans.

Some types of bacteria produce toxins in NRTE/RTE products as a by-product of their growth. Toxins of most concern are produced by *Clostridium botulinum*, *Clostridium perfringens*, *Bacillus cereus*, and *Staphylococcus aureus*. All are the result of the growth of bacteria and the production of toxins in foods that have been mishandled. These bacteria are common in the environment and are often found on carcasses. The environment (air, water, and soil) is the common source of these types of bacteria. An exception is *Staphylococcus aureus*, which is commonly found in association with human skin, and sometimes in poultry bruises. The hazard is the toxin (e.g., enterotoxin, neurotoxin, hemotoxin) produced by the organisms. The organism may contaminate the product if improper handling occurs after the product has been cooked. Proper cooking, fermentation, cooling, and storage of food can prevent growth of these bacteria and, more importantly, the production of their toxins. However, cooking will not

destroy several of these toxins once they are formed in food.

Parasites (parasitic worms) of public health importance are the beef and pork tapeworms (*Cysticercus bovis* [the larvae of the human tapeworm, -*Taenia saginata*] and *Cysticercus cellulosae* [the larvae of the human tapeworm - *Taenia solium*] respectively) and the roundworm that causes trichinosis (*Trichinella spiralis*). Federal and state inspection program personnel can observe the immature stages (cysts) of tapeworms in carcasses of animals with severe infection and when detected by government inspection personnel or plant employees such product cannot be further processed for human consumption. When the cysts are less severe or evident, infected meat may enter the human food chain after it has been appropriately treated. Humans consuming undercooked meat infected with these tapeworms become ill generally after the mature stages of the tapeworms invade the intestinal tract.

Trichinella spiralis is an intestinal worm that produces larvae that migrate to and encyst in muscles of a number of animals, particularly swine. Humans consuming infected pork which is undercooked may get ill from the cysts which then live in the muscles of the human hosts. Pork muscle tissue may carry *Trichinella spiralis*, better known as trichinae. Specific regulatory requirements that outline procedures to control *Trichinella* are found in 9 CFR §318.10. *Trichinella spiralis* is an additional biological hazard that may be addressed in the manufacturing of processed pork product, especially if the product is intended to be eaten without thorough cooking by the consumer.

Tapeworms and roundworms generally are readily destroyed at cooking temperature and time combinations less rigorous than the combinations necessary to destroy pathogenic bacteria.

Viruses can cause gastroenteritis and diseases such as hepatitis and polio in humans. The presence of viruses in food and water is generally associated with a contaminated food worker, usually in the retail or food service arena. In general, healthy animals do not serve as carriers of viruses. Viruses do not normally grow or reproduce in meat and poultry products. Meat and poultry products may serve as vectors for viruses.

Protozoa can cause diseases such as sarcocystosis, toxoplasmosis and cryptosporidiosis. These organisms are not usually considered under food safety concerns for meat and poultry products.

2) Public Health Concerns

It is particularly important for establishments to identify and control these biological hazards in RTE products, because the consumer is not expected to cook these products further. In not shelf stable (NSS) RTE products, the lethality step is the intervention that protects the consumer from most biological

pathogens. However, *Listeria monocytogenes* can pose a food safety risk in NSS RTE products if this pathogen is not properly controlled post lethality in the processing environment. Products that are NSS heat-treated (such as products in the 03H and some in the 03I regulatory processing category) can pose a food safety risk if some pathogenic bacteria remain on the product which must be controlled. In addition, products that are NSS and produced with secondary inhibitors, especially those that may be RTE, can pose a food safety risk if the pathogenic bacteria are not prevented, eliminated, or reduced to acceptable levels as many of these products have not had heat applied but rely on other strategies to control the food safety hazards.

Type of bacteria of concern for NSS NRTE/RTE products

Species harboring organism	Organisms				
	<i>Salmonella</i>	<i>E. coli</i> O157:H7	<i>Campylobacter</i>	<i>Listeria monocytogenes</i>	<i>Yersinia enterocolitica</i>
Beef	+	+		+	
Lamb	+			+	
Pork*	+			+	+
Poultry	+		+	+	

* Trichinae control may be required in certain products

There are definite public health concerns associated with bacterial toxins in NRTE/RTE products. Toxins may be produced during the growth phase of some bacteria. These are called preformed toxins, such as *C. botulinum* toxin, and when they are ingested, they may cause headaches, disorientation, neurological damage, paralysis, and possibly death. The toxins may affect the nerve endings and interfere with nerve impulses. In the case of botulism toxin, the diaphragm is affected and death results from suffocation. Other toxins are formed when the vegetative cell produces a spore. Some spore-forming bacteria form spores in the human digestive tract because the digestive juices are too harsh for the vegetative cell and the self-preservation mechanism (spore formation) is turned on. This is true for *C. perfringens*. The common form of perfringens poisoning is characterized by intense abdominal cramps and diarrhea which begin 8-22 hours after consumption of foods containing large numbers of those *C. perfringens* bacteria capable of producing the food poisoning toxin.

Type of toxin producing bacteria of concern for NSS NRTE/RTE products

Species harboring organism	Organisms			
	<i>Staphylococcus aureus</i>	* <i>Clostridium perfringens</i>	* <i>Clostridium botulinum</i>	* <i>Bacillus cereus</i>
Beef	+	+	+	+
Lamb	+	+	+	+
Pork	+	+	+	+
Poultry	+	+	+	+

Primary 03 HACCP Element	03I	03G/03H	03G/03H	03G/03H
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* Spore formers

A public health concern associated with zoonotic agents is trichinosis, a disease that results from ingesting pork cysts in undercooked pork products. Due to improvements in animal production processes, trichinosis is quite rare in this country. Once ingested with the meat, the larvae bore through the intestinal wall and travel through the blood and lymph to encyst in muscles. If there is a heavy enough infestation, based on the amount of *Trichinella spiralis* ingested, the encysting process within muscles is painful. If the worms encyst in the diaphragm, they may interfere with breathing.