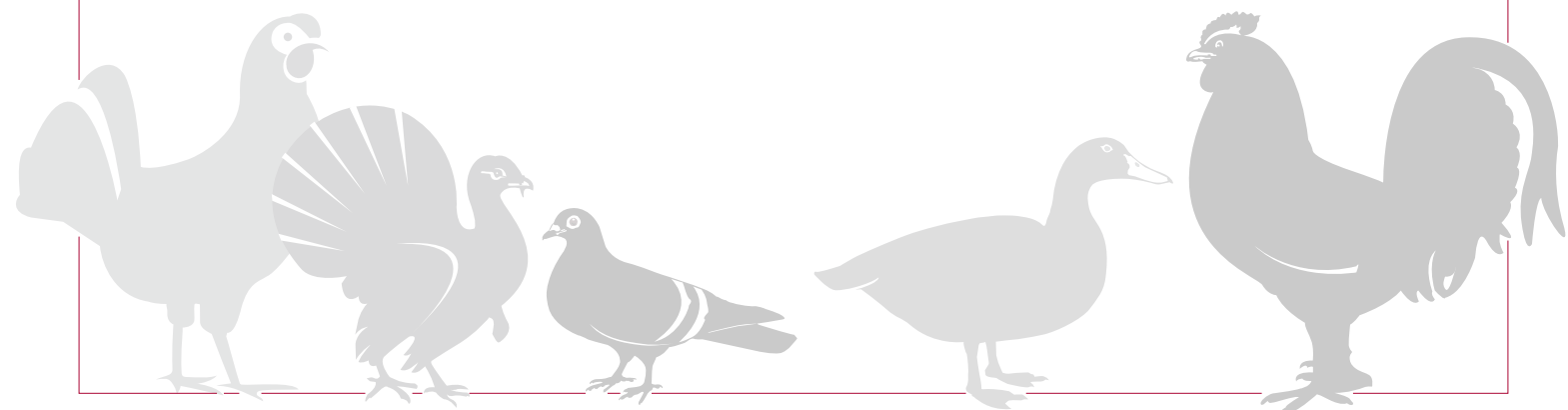


Poultry and poultry products - risks for human health



Consumption

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INTRODUCTION

Unless all the necessary precautions are taken along the poultry production, marketing and processing chains, poultry meat and eggs can be contaminated by infectious agents that are harmful to humans. Poultry products can also be contaminated with the antimicrobial and anti-parasitic drugs or pesticides used on farms. The ingestion of antimicrobials can cause antimicrobial-resistant bacteria to develop in humans.

Campylobacter and *Salmonella* infections are among the most important food safety hazards. These bacteria account for more than 90 percent of all reported cases of bacteria-related food poisonings worldwide. Most of these cases are related to the consumption of poultry and poultry products, but all domestic livestock are potential reservoirs of infection. Reported cases of *Campylobacter* and *Salmonella* infections are believed to represent only a fraction of the true number of cases.

Consuming raw or undercooked poultry or poultry products has been implicated as a potential risk factor for human cases of influenza H5N1 infection (HPAI). Poultry meat should be well cooked, with the core temperature reaching 70°C for at least one second during cooking.

Data on food-borne diseases in low-income countries are scarce. There is no precise and consistent global information about the full extent of the occurrence of food poisoning and the costs related to unsafe food. Symptoms are often mild and cases are not reported, but their importance is thought to be substantial.

RISK FOR CONSUMERS

In many countries, eating habits have undergone major changes over the last two decades. The middle class is growing, and this group of people eats more meat and goes out more often for meals. Migration from rural to urban areas has also resulted in changed eating patterns. New food production, preparation and distribution techniques have developed in response to these changes. There is a large increase in “fast food” and other ready-to-eat foods, which means that consumers have less control on the selection, preparation and storage of the meat they consume.

Children and people in stress situations, such as those facing malnutrition, war or natural disasters, are especially at risk of food-borne bacterial diseases. The main symptom is diarrhoea, and infection can be fatal (with 0.01 percent mortality in infected people in high-income countries). As the causal agent is a bacterium, these diseases can be treated by antibiotics, but access

to treatment is difficult in many low-income countries. Another problem is the development of resistance to antibiotics among zoonotic bacteria.

PRODUCTION SYSTEMS

Backyard poultry production is an important activity for many rural households. Consumption of meat and eggs from this production system is considered safe because of the habits usually observed among consumers purchasing or preparing birds from backyard poultry production. Preparation is usually just after slaughter. Because a chicken provides one meal for a family, there are usually no leftovers. The meat is thoroughly cooked, which reduces the risk associated with the consumption of sick birds that is observed in many poor rural areas. If birds are infected, there is risk of human infection with pathogens during the handling of live birds and during preparation.

People with little or no experience of poultry farming may invest in smallholder intensive poultry production and may build a small broiler or layer chicken house, often near new settlements or suburbs. In these small-scale operations, the use of antibiotics – which is sometimes adopted to compensate for poor performance resulting from inexperience in management – is not adequate. The risk of consumers ingesting antimicrobials and/or antibiotics is particularly important.

In general, poultry meat and egg products from large-scale commercial operations are subject to efficient control processes and are safe. Large companies normally take considerable care to avoid bad publicity resulting from the commercialization of unsafe food products. However, one of the most common problems for large-scale commercially produced poultry meat in low-income countries is the lack of refrigeration during marketing. Table 1 gives an overview of risk factors for food-borne diseases related to the consumption of poultry and poultry products from production systems in low-income countries.

REDUCING RISKS

The appearance of clinical signs in infected humans, and the importance of these signs will depend on several factors. On a chilled carcass taken out of the refrigerator, most bacteria need an adaptation time of about two hours before they start to multiply. Usually, only high numbers of bacteria will cause disease, and only in more vulnerable people. Consumers can reduce the risk of bacterial food-borne diseases by refrigerating the meat from the moment it is bought until the moment of preparation (heating)

¹ With contributions from Philippe Ankers, FAO

TABLE 1
Quality control and risk factors in low-income countries

Characteristics	Production system		
	Backyard	Smallholder intensive	Industrialized
Production chain	Short	Medium	Long
Quality control during production	-	±	+++
Quality control during slaughter	-	±	+++
Product	Live birds	Live or locally slaughtered birds	Frozen parts, defrosted at the market
Contact between consumer and live product	+++	++ in live-bird markets or poultry shops	-
Refrigeration chain	Not necessary, immediate preparation of whole carcass	Often not available	Often interrupted because of long chain
Consumer risk from bacterial contamination	+	++	+++ if refrigeration chain is broken
Consumer risk from resistant bacteria	-	+	+
Consumer risk from veterinary drugs residues and pesticides residues	-	+++	-

+ = present; - = absent

for consumption. Temperature and cooking time are critical in minimizing risk. Contaminated parts are less likely to cause food poisoning problems if the meat is well cooked. However, some bacterial toxins are heat-stable, and will not be deactivated. Proper attention to minimizing bacterial contamination and proliferation is required from slaughter until cooking. Coagulated blood, blood pudding and chicken-and-duck blood soup can contain harmful pathogens if not well cooked.

The World Health Organization (WHO) has elaborated the Five Keys to Safer Food programme (<http://www.who.int/foodsafety/consumer/5keys/en/>). Messages for food handlers and consumers have been developed, to decrease the incidence of food-borne diseases. Educational and training tools have also been developed. Education is an important measure for preventing risks to human health from poultry products.

Knowledge = prevention!

Thoroughly cooking in stew pans is fairly common in developing countries. The widely practised habit of washing the skin or

cutting the surface of the poultry meat before cooking helps to reduce bacterial contamination.

CONSUMER PROTECTION

The pattern of food-borne disease outbreaks has changed during the last two decades. In the past, most outbreaks were acute and localized, and resulted from a high level of contamination. Now, more outbreaks affect several countries at once, resulting from low-level contamination of widely distributed commercial food products. Risks of the contamination of poultry products by residues and bacteria exist everywhere, owing to the globalization of poultry production and trade. Counteracting this, the relative risk of contaminated poultry products reaching the market has reduced in the last decade, thanks to faster and more reliable diagnostic tools, the establishment of a world epidemiological alert system, and overall improvement of hygiene standards. The availability of efficient antibiotic treatments has also reduced the impact of food-borne diseases.

As most food safety hazards related to poultry come from the immediate health risks of ingesting foods contaminated with zoonotic bacteria, regulation and testing efforts have focused on reducing the incidence of this type of contamination. Over recent decades, the food chain approach has been recognized as a valuable step forward in ensuring food safety from production to consumption. Such a system can also control contamination with pesticides and veterinary drugs along the production and marketing chains.

The many and varied routes of contamination mean that many actors have a role in reducing risk, including feed mill operators, farmers, chicken processors, retailers, supermarkets, restaurants, takeaway establishments, health authorities, legislators, governments and consumers.

Flock health, the structure of the poultry food chain (short or chilled), the quality of control procedures during production and supply processes and on the final product – all contribute to the marketing of safe poultry meat and eggs.

WHO has set up a Food-borne Disease Burden Epidemiology Reference Group (FERG), which harmonizes international efforts



Coagulated blood for consumption

to estimate and reduce the global importance of food-borne diseases. This will help countries to estimate the magnitude of food-borne illnesses and to evaluate progress in their control. FERG will provide initial estimates of the importance of food-borne diseases worldwide by 2012. An international network of laboratories, alert systems and collaboration among authorities assist in solving food safety problems.

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Marketing

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INTRODUCTION

Since the 1990s, the production of poultry meat in low- and middle-income countries is increasing, with chicken meat accounting for 80 percent, and duck and goose meat production also increasing. China and Brazil, in particular, have emerged as major poultry meat producers. Meanwhile North American and European producers have lost their global market shares. Over the last 30 years, egg production has also increased enormously in East and Southeast Asia. In 2007, about 45 percent of the eggs consumed worldwide were produced in China (FAO, 2009).

INTERNATIONAL TRADE

In most countries, poultry production is mainly for domestic consumption. According to FAOSTAT, only about 12 percent of poultry meat and 2 percent of eggs were traded on the world market in 2007. However international trade is increasing. Brazil and the United States are the two largest exporters of poultry meat. Global trade in poultry meat and meat products involving processing is complex.

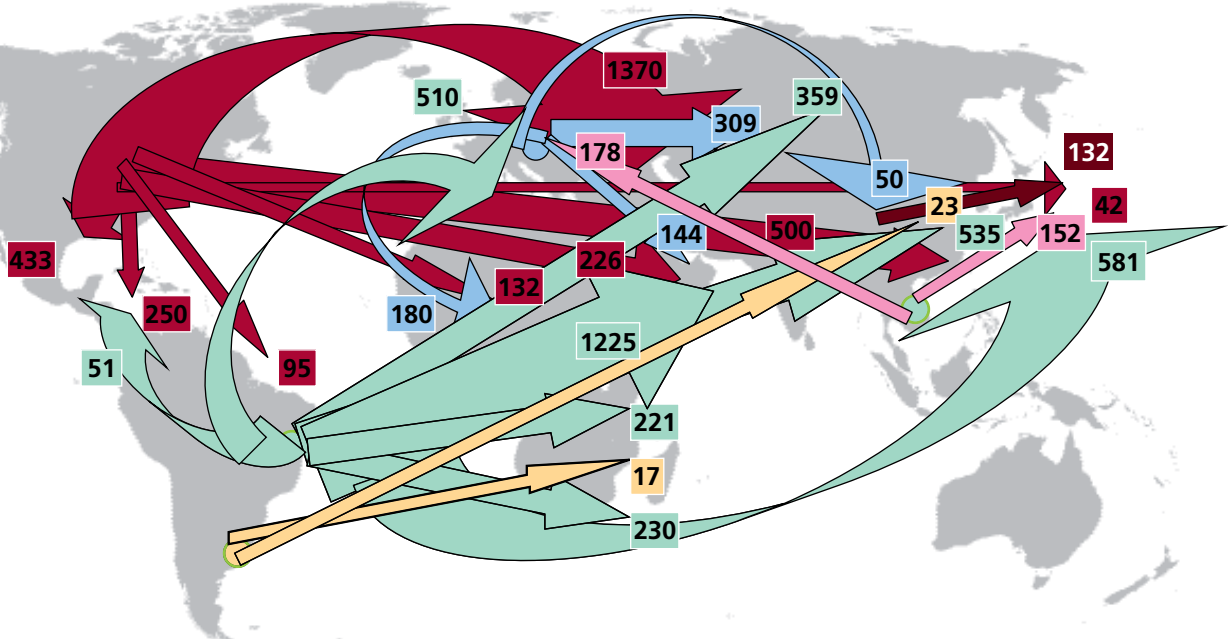
Most of the poultry meat available on the global market comes from large-scale specialized commercial poultry production systems. In low-income countries, imports of cheap low-quality cuts such as wings, lower legs, necks and giblets sold by the piece, make chicken meat more accessible to the average consumer. This coincides with changing eating habits in developed countries, where consumers tend to buy chicken breast and thigh meat and, to a lesser extent, drumsticks. Poultry meat products are usually exported frozen.

In many low-income countries, particularly those with tropical climates, trade in frozen food entails risks. It is not uncommon to see defrosted poultry meat displayed for sale on open market stalls without refrigeration, which presents a risk to human health. The smaller the pieces, the higher the risk of contamination, owing to the increased surface area. Carcasses or cut-up pieces must remain frozen throughout the marketing chain.

When the refrigeration chain is interrupted, infectious agents start to multiply on the meat. The consumption of contaminated meat can cause diseases, especially if the meat is not well cooked.

FIGURE 1

Poultry meat and meat product imports and exports 2008, including live birds ('000 tonnes carcass weight equivalent)



Source: Gira Meat Club.

¹ With contributions from Philippe Ankers, FAO



Frozen chicken pieces displayed at markets are a health risk for the population

Appropriate control of the refrigeration chain is therefore required, from port, to market, to consumer.

If other food, such as salad, comes into contact with raw contaminated poultry meat, it too can be contaminated and will be dangerous to health when eaten raw. Cross-contamination during food preparation is another important risk factor.

In countries where H5N1 highly pathogenic avian influenza (HPAI) is reported, poultry meat can be exported only as processed products (cooked, pasteurized) to avoid spread of the virus to other countries. In frozen poultry meat products Influenza viruses are not killed by refrigeration or freezing, but human cases of influenza H5N1 infection are mainly the results of direct contact with live birds (Swayne and Thomas, 2008).

Bacteria, such as *Salmonellae*, which cause Salmonellosis in people, also survive in frozen products, and can become harmful when they start multiplying after defrosting. Antimicrobial-resistant bacteria can also be disseminated through trade of poultry meat products.

INTERNATIONAL FOOD SAFETY STANDARDS

For World Trade Organization (WTO) member countries, the Sanitary and Phytosanitary (SPS) Agreement defines the basic rules for food safety and animal and plant health standards. It allows countries to set their own standards, but these must be based on science. The Codex Alimentarius is a collection of international food safety standards that have been adopted by the Codex Alimentarius Commission (the Codex), which was jointly set up by FAO and the World Health Organization (WHO). Under the SPS Agreement, the Codex is the relevant standard-setting organization for food safety. The Codex Alimentarius includes food safety standards related to poultry meat and eggs. Harmonizing application of the CODEX standards among countries is a challenge. Consumers' perceptions of the risk related to food consumption differ among countries, as do the availability of market information, the importance of risk factors at the farm level, and the standards for food processing and packaging technologies. The benefits of applying a specific food safety standard may exceed the costs in some countries, and various food safety risk control measures can achieve similar results. As risks for food safety vary among countries, the identification of

risk factors for each poultry product is a first step in risk control, as described in the CODEX.

LOCAL TRADE

In many low-income countries, local chickens are traditionally sold alive at live poultry markets (also called "wet markets"), where slaughtered birds or poultry meat can also be purchased. Live-bird markets are considered critical risk points for the spread of the H5N1 HPAI and other viruses. Authorities may decide to close these markets when there are outbreaks in the area, region or country. In the medium to long term, authorities will encourage the purchase of poultry meat that has gone through a certification process. Contact between people, especially children, and live poultry bought at the market should be discouraged.

OUTLOOK

Global demand for poultry and poultry products will continue to increase, owing to global population increase and growing per capita consumption. Trade will also go up, facilitated by improvements in transportation, infrastructure and marketing networks. These factors, and the rapidly changing regulations and rising standards for food safety in high-income countries, create both challenges and opportunities for low- and middle-income countries.

For many years, intensive poultry production units in high-income countries have approached risk management by focusing first on risk identification and then using Hazard Analysis Critical Control Points (HACCP) procedures. This approach is now adopted by producers in low- and middle-income exporting countries as well. The Codex committees provide advice on the introduction of such procedures. Regulatory agencies worldwide are also increasingly adopting the HACCP procedures as a foundation for new regulations to control microbial pathogens in food. Based on risk assessment, critical control points are identified in the production chain, and adjustments in the chain will ensure the quality of final products.

Governments and the private sector must join forces to improve capacity to react quickly to emerging food safety crises, thereby minimizing human illness and financial losses.

An increasing number of low- and middle-income countries are exporting poultry and poultry products, and the adoption of international standards for food safety is essential. Brazil's remarka-



Live-bird market in Asia

ble development as a major chicken meat exporter was facilitated by the adoption of strict food safety regulations, and provides an example for neighbouring countries.

Poultry export control systems are self-financing. Certification is mandatory in this profitable business. The private sector usually pays for these controls, but government official services and a product board are sometimes involved in carrying them out. Public health and veterinary services must be involved, ideally together, in controlling the entire marketing system within the country, from large-scale integrated operations, down to live-bird markets and small slaughter shops, where they exist.

The refrigeration chain for poultry meat is a key factor in food safety, and must be guaranteed by a system in which certificates are required to permit the sale of products. An example of this is the implementation of minimum hygiene criteria for street sellers. In small-scale production systems, only the government can undertake such control, for economic reasons. It requires support from strong legislation and enforcement to prevent false competition.

The protection of human health during H5N1 HPAI outbreaks is also a responsibility of government. Government has all the centralized information about the spread of the disease, and can – under certain circumstances – prohibit the operation of live-bird markets and indicate other safe sources of poultry meat.

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Slaughtering and processing

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INTRODUCTION

Handling of live birds brings perhaps the greatest risk of exposure to viruses for farmers, their families and poultry workers in areas where highly pathogenic avian influenza (HPAI) is present. A study in Guangzhou, China in 2007 to 2008 found that 15 percent of poultry workers in live poultry markets, where the birds are also slaughtered, had antibodies against HPAI. This compares with only 1 percent in the general population (Wang, Fu and Zheng, 2009).

However, there are also risks of human exposure to pathogens originating from the poultry slaughtering, processing, storage, handling and preparation phases. Poultry can be contaminated with harmful infectious agents, and raw poultry products are reported to be responsible for a significant number of cases of human food poisoning.

During these phases, controlling the contamination of carcasses by such pathogens presents a considerable challenge, especially in small-scale operations. In tropical countries, the ambient temperature is usually above 20°C, with a high degree of humidity creating favourable conditions for the multiplication of most bacteria. During the hot season, increased numbers of bacteria are found on poultry carcasses.

To quantify the food safety risks along the production and marketing chain, it is important to know how, where and when contamination with microorganisms occurs. Once this is known, it is possible to introduce risk reduction measures. The adoption of improved technology and strict hygiene measures can often reduce the risk of contamination of carcasses. The slaughtering facility must be divided into at least three separate sections: a live birds' area; a slaughtering area, including defeathering; and a processing area, starting with evisceration. To reduce the risk of pathogens multiplying on carcasses, poultry meat and carcasses should be refrigerated or consumed immediately after slaughter.

The native microflora of processed poultry is composed of many types of bacteria and yeasts, most of which are part of the microflora of live poultry. This microflora is carried into the processing facility on the body and in the intestines of the birds. For example, the bacteria *Campylobacter* spp. and *Salmonella* spp. inhabit the intestines of healthy birds, and can cause disease in humans, depending on their pathogenicity and the number and concentration of bacteria on the product. The sum of these factors will determine whether the consumer is at risk at the time of consumption.

The cleaner the birds are when they arrive at the slaughter place, the fewer the bacteria on their carcasses during slaughter-

ing. On many farms, it is difficult to achieve low bacterial counts on the skin and feathers of birds, so emphasis should be placed on hygiene at the slaughter line.

LARGE-SCALE COMMERCIAL SLAUGHTERHOUSES

In modern large-scale slaughter plants, appropriate equipment is used and there are strict procedures for minimizing contamination. Nearly all procedures are automatic, and birds' contact with surfaces or poultry workers is kept to a minimum; for example, the carcasses are scalded in a counter-flow system, with the water flowing from clean to dirty, in the opposite direction to the birds. Automation enables the efficient control of hygiene, residues, etc. Although control systems are expensive, the large scale of operations means that this expense will have only a marginal effect on the prices of final products. These technical solutions and controls ensure delivery of a very safe product. If the processed carcasses are kept refrigerated and delivered rapidly to the supermarket, and kept there under appropriate temperatures, the consumer can be assured of buying a safe poultry product.

SMALL-SCALE SLAUGHTERING FACILITIES

In small-scale slaughtering facilities, birds are killed and then scalded in hot water. The carcasses are then plucked and eviscerated, mostly by hand. Before and after evisceration, carcasses are often washed, which may contribute to the dissemination of bacteria on and among carcasses. Further down the marketing chain, trussed birds are often displayed on shelves at ambient temperatures until they are sold. Unsold birds may be put into a refrigerator overnight.

When ambient temperatures are moderate to high (above 20°C) the microorganisms will multiply quickly, resulting in rapid deterioration of the meat's quality and safety, if the products are not cold-stored.

Traditional slaughtering during the hot season has been found to result in a significantly increased incidence of bacterial flora on poultry carcasses (Cohen et al., 2007). When carcasses are properly cooled (at 4 to 10°C), the growth of pathogens slows down.

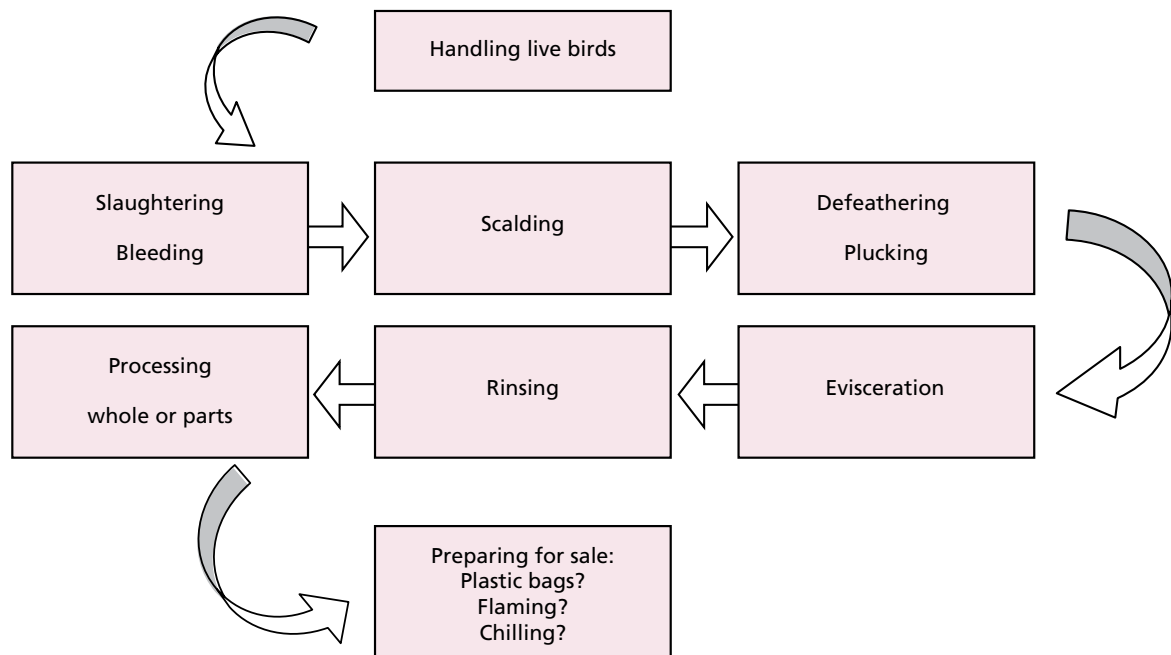
REDUCING CONTAMINATION OF POULTRY CARCASSES IN SMALL-SCALE SLAUGHTERING FACILITIES

Birds to be slaughtered should be clean and dry; the cleaner they are the less contaminated their carcasses and meat will be (Bolder, 2007). To avoid the soiling of feathers with faeces, crates for

¹ With contributions from Philippe Ankers, FAO

FIGURE 1

Steps in small-scale slaughtering



transporting poultry should not be stacked on top of each other, unless there are solid partitions between them.

The people slaughtering the birds should take precautions, by washing their hands frequently and avoiding the splashing of blood on to their face and clothes.

Placing the birds into cones for slaughter prevents the spread of microorganisms, because it prevents the birds from flapping during **bleeding**. The spreading of feathers during the slaughter

process is also reduced, and hygiene is improved. Blood, which can contain pathogens, is collected in the trough beneath the cone and will not be splashed.

Commercial poultry processing plants defeather carcasses mechanically, after the feathers have been loosened by scalding (Arnold, 2007). **Scalding** involves immersing the carcasses in hot water (for four minutes at 50 to 58°C, or by dipping several times in water at 65°C), to loosen the feathers from the skin. In small-scale operations, this scalding is often done in a cooking pan. An under-scalded carcass will be difficult to pluck, while an over-scalded one will show torn skin or cooked flesh. Harmful bacteria and viruses can survive the scalding process. In some cultures, birds are scalded in boiling water. This reduces the risk of spreading viruses, but may cook the flesh. The quality and temperature of the scalding water are critical in determining the final degree of carcass contamination. The water should be frequently replaced.

Cross-contamination among carcasses is an important problem during the **defeathering** process. Mechanical defeathering equipment work centrifugally; the carcasses are rotated and the feathers are rubbed off by rubber fingers. Carcass contamination can occur through:

- direct contact between contaminated and uncontaminated carcasses;
- compression of the carcass, resulting in expulsion of internal faeces to the carcass surface;
- the mechanical fingers;
- contaminated feathers remaining in the plucker.

At **evisceration**, the vent is opened, the internal organs are removed, and the gizzard, liver and heart may be harvested. Carcasses can be contaminated through spillage of the contents of the intestines.



Fixation in funnels during bleeding to prevent spread of micro-organisms

Photo Credit: Centre For Livestock and Agriculture Development (Calagrid)



Mechanical fingers should be renewed regularly, as cracked and worn fingers can harbour bacteria

Photo Credit: Copyright 2008, Charlotte Observer / MCT



Hanging is hygiene!

The contamination of carcasses and meat with poultry bacteria is not the only health risk to humans; the bacteria carried by poultry workers can also be transferred to the carcasses and subsequently to consumers. *Staphylococcus aureus* is a bacterium of particular concern here. Where evisceration is done by hand, as in traditional slaughter places, there is a potentially serious risk of contamination with these bacteria. Infrequent hand-washing exacerbates the problem. The primary factor contributing to staphylococcal food poisoning outbreaks is inadequate control of temperature after slaughter, with the initial contamination often being traced to poor personal hygiene by food handlers. If slaughter is followed by storage at temperatures that permit bacterial growth and multiplication, toxins will be produced. Staphylococcal toxins are noted for their heat resistance, and typically they cannot be inactivated by the normal heat processing of food (Cohen *et al.*, 2007). This means that once the toxins are present in the uncooked meat, people will get sick even from thoroughly cooked food.

Where carcasses are **rinsed** (with a shower or spray), the water used should be of drinking quality. Washing with cold water reduces the quantity of microorganisms on the carcass in the slaughter process.

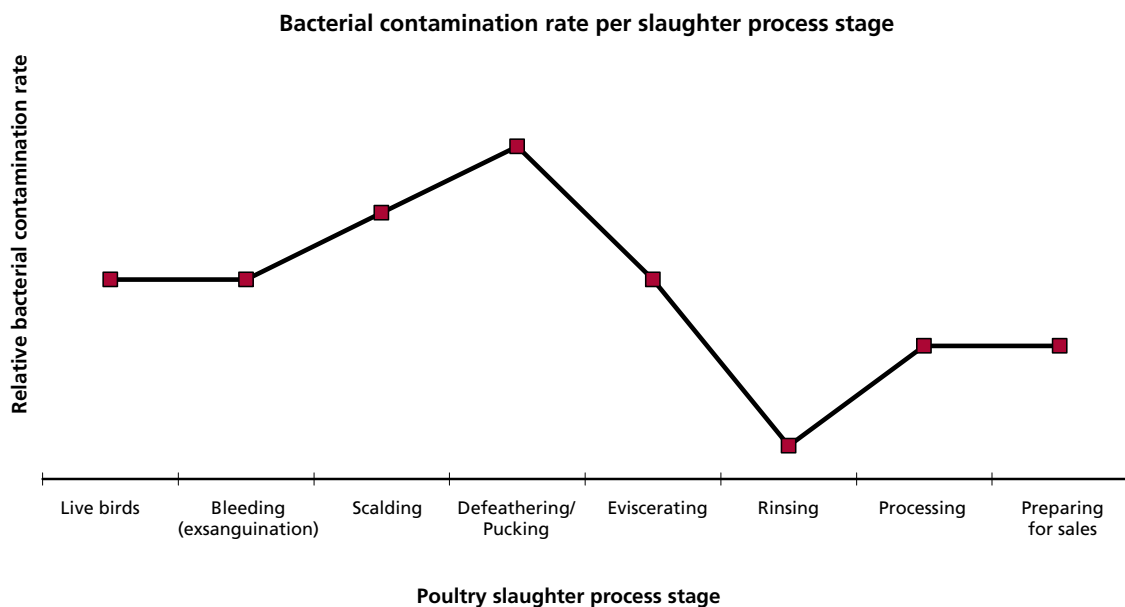
For good hygiene, and to wash away all the dirt and bacteria, etc., a regular supply of clean water is essential. Water should also always be available for personal hygiene and the cleaning of knives and other utensils. Water quantity and quality determine the level of hygiene.

Cross-contamination of carcasses can occur on working tables, sinks or draining boards during **processing**. The best way of preventing contamination of clean carcasses is to hang the birds. Abattoir workers handling the carcasses and contaminated knives can also act as vectors for the cross-contamination of carcasses.

When **preparing for sale**, bird carcasses are sometimes put into plastic bags, which prevent further carcass contamination. In

FIGURE 2

The contribution of each stage of the slaughter process to bacterial contamination



Source: Logue and Nde, 2007.

other cases, the surface of the carcass is flamed, which is a good method for reducing the number of bacteria contaminating the carcass. Quick chilling at 4 to 10° C is the best way of preventing bacterial growth.

REDUCING CONTAMINATION FROM BY-PRODUCTS AND WASTES

Feathers, especially from ducks and geese, are used for duvets and clothing. Feathers for trade are pasteurized, which kills most viruses, including H5N1 HPAI virus, and leaves the product safe (Beato, Capua and Alexander, 2009).

Poultry slaughter waste, such as carcasses, blood, feathers and offal, should be properly disposed of. It can contain viruses, bacteria and residues. In resource-poor areas, burning or burial are the most likely, practical and effective methods for disposing of waste (Nicholson, Groves and Chambers, 2005).

COMMUNICATION FOR BEHAVIOURAL CHANGE

Recently, biosecurity and good hygiene measures have been promoted more intensively in many places, in response to the risk of influenza H5N1 infection in humans. The training of trainers, workers at slaughter facilities and producers themselves helps reduce the risk of exposure.

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