monocytogenes, represents a major concern for food safety worldwide. Food can become contaminated with microorganisms that can cause human illness from multiple sources along the entire food chain, starting from infections in live animals up to the point of consumption. Preventing such contamination will reduce foodborne illness and decrease the likelihood of novel pathogens emerging in the food chain. Although millions of rural people rely on wildmeat for food, ensuring food safety along the wildmeat value chain is difficult because a substantial proportion of the product moves through informal – if not illegal – markets.

Live animals that appear healthy can silently harbour dangerous pathogens

Live animals, whether domestic or wild, can be infected with pathogens (*Brucella* spp., *Salmonella* spp, *Mycobacterium tuberculosis*, *Trichinella spiralis* and Ebola virus) that can also cause illnesses in humans. Such risks are an invisible yet occupational hazards for farmers, hunters, butchers and other food business operators. These organisms may be present throughout animals' tissues and products such as muscles, milk and eggs, making food unsafe. In some cases, they may be limited to the gastro-intestinal tract and will only contaminate animal tissue and products if good practices in dressing, handling and preparation are not observed. Animal health inspections provide a valuable tool to identify clinical signs caused by these microorganisms and to exclude affected animals from the food chain.

Unfortunately, zoonotic agents do not always present outward signs of disease or infection in the animal hosts. Furthermore, it is not feasible to perform health inspections on live animals hunted for food, with the possible exception of captured wildlife. As some animals carrying pathogens may be asymptomatic, it is not always possible to exclude them from the food chain. Inspection of animal carcasses immediately post-harvest for visible signs of pathology can provide an indication of the wholesomeness of carcasses of both wild and domestic animals. However, this approach to food safety falls short in its ability to identify most microbiological hazards, particularly those that are only carried in the gastro-intestinal tract and do not cause animal disease. The application of a risk-based systematic approach to assess and control microbial hazards, based on risk across the food chain, helps to overcome the limitations of visual pre- and post-harvest inspections to enhance food safety. This involves appropriate slaughter techniques, combined with proper sanitation and personal hygiene throughout the entire food chain.

Appropriate slaughter techniques are necessary to minimize food safety risks

Animals with gastrointestinal infections contaminate their environment with faeces laden with pathogens. The location where animals are held prior to slaughter can become contaminated with faeces and other secretions containing pathogens and serve not only as a source of infection to the animals and contaminate their hides and feathers, but may also contaminate the cages or pens from which pathogens may be aerosolized. Accordingly, animal waste, hooves, hides and feathers constitute important sources of occupational exposure and contamination of meat and other animal products. Thus, transmission of zoonotic agents can occur without direct contact with infected animals.

Wet markets, where live animals are held, slaughtered and dressed, pose a particular risk for pathogen transmission to both workers and customers alike. To reduce risks, lairage areas should be cleaned regularly to reduce the risk of pathogen transmission. Care is required during the stages of stunning, defeathering, dehairing, hide removal and evisceration to minimize contamination of the underlying and internal edible parts of the animal.

Keeping the environment and all equipment, tools and surfaces clean is critical to food safety

While live animals can be a source of pathogens, all types of food can potentially be contaminated though contact with any contaminated equipment, surfaces or environment. Proper cleaning and prevention of cross-contamination are critical in the control of foodborne illnesses. Once pathogens are deposited on surfaces by a previously contaminated product (cross-contamination), aerosols or touch from contaminated hands or clothing, they can survive on inanimate objects such as knives, saws, transport containers and conveyer belts made of metal, plastic and wood. Coronaviruses have been shown to remain infectious for up to nine days on such surfaces.

Most pathogens, including coronaviruses, are susceptible to destruction and removal with most common disinfectants and sanitizers used in food processing. A 0.05 percent hypochlorite solution, equivalent to a 1:100 dilution of household bleach is effective at killing most pathogens and can be used to disinfect surfaces after cleaning. It is important to follow manufacturers' recommendations regarding disinfectant use, notably the need to first remove organic matter that can inhibit contact and neutralize the efficacy of disinfectants; dilution of the disinfectant; and the contact time required to be effective. If alcohol is used as a disinfectant, it should contain a final concentration of between 60 percent and 85 percent. Most commercially available spirits distilled for beverages do not contain an adequate concentration of alcohol to be effective as a sanitizer for the hands or the environment.

Personal hygiene is essential for food safety and ill people should avoid handling food

Many human pathogens are excreted in the stool during infection and even when individuals show no clinical signs after apparent recovery. For example, although diarrhoea presents only as a symptom in a small portion of COVID-19 patients, the virus is present in the stool of almost half of cases. Inadequate handwashing after bathroom use is responsible for many foodborne disease outbreaks, the most famous example being that of Typhoid Mary (Mary Mallon) who was attributed with infecting over 50 individuals during her work as a cook while asymptomatically shedding *Salmonella* Typhi. Strict personal hygiene, including effective handwashing and use of clean protective clothing, are essential in preventing food contamination.

Sick individuals may also contaminate their environment and surroundings by sneezing or coughing. In food-processing environments, this presents an opportunity for contamination of any equipment in the vicinity, and contamination of food directly or through cross-contamination from surfaces or workers' hands to food. Food workers experiencing clinical gastrointestinal or respiratory disease symptoms should not participate in food processing or preparation.

Observe good hygienic practices when handling fresh food that will be consumed raw

Good hygiene practices are particularly important when handling fresh foods that may be consumed raw and/or without any further processing. Examples include fresh fruits and vegetables and ready-to-use foods for consumption without further heat treatment. These can be particularly susceptible to contamination from the environment and food handlers. To

minimize risk of exposure to any foodborne bacteria and viruses, it is important to keep food contact environments, equipment and tools clean, observe good handwashing practices, and separate raw and cooked foods and use clean water.

Foods of animal origin should be adequately heat-treated and protected from recontamination

Although foodborne transmission of COVID-19 has not been reported, avoiding raw and undercooked foods of animal origin (meat, eggs, milk products) will reduce exposure to all viruses and other foodborne pathogens. The virus responsible for the disease does not exhibit a unique resistance to heat and adequate cooking. Reaching an internal temperature of (70°C) is sufficient to kill it and any other pathogens in meat. Viruses cannot multiple and increase in numbers in foods. Nevertheless, both prior to and after cooking, meats should always be stored in a way that ensures that they cannot contaminate other foods and cannot be re-contaminated after cooking. It should be noted that viruses resist freezing and can be found in food frozen for up to two years at minus 20°C; therefore, adequate cooking of frozen food is also indicated.

CONCLUSIONS

Specific information about the virus responsible for COVID-19 is and remains scant; however, the behaviour and characteristics of the virus can be predicted based on data from similar viruses such as those responsible for Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS). Despite the hypothesis that the virus may have originated in bats and infected another animal used for food, there is no evidence of continued transmission of the virus from animals to humans through the food chain. **The application of sound principles of environmental sanitation, personal hygiene and established food safety practices will reduce the likelihood that harmful pathogens will threaten the safety of the food supply, regardless of whether the food is sourced from intensive agriculture, small stakeholders or wildlife.**

The Codex Alimentarius Commission[1] has adopted several practical guidelines on how to apply and implement best practices to ensure food hygiene (*Codex General Principles of Food Hygiene*, CXC 1-1969),[2] handle meats (*Codex Code of Hygienic Practice for Meat*, CXC 58-2005)[3] and control viruses in foods (*Guidelines for the Application of General Principles of Food Hygiene to the Control of Viruses in Food*, CAC/GL 79-2012).[4] Enhanced food safety practices at this time, such as those recommended in the Codex documents, will reduce the likelihood of contamination of foods with pathogens, and help lower the public health burden caused by established foodborne infections, reducing the stress on an already taxed public health system.

[1] www.fao.org/fao-who-codexalimentarius/home/en.
[2] www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXC%2B1-1969%252FCXP_001e.pdf.
[3] www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXC%2B58-2005%252FCXP_058e.pdf.
[4] www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXG%2B79-2012%252FCXG_079e.pdf.

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