Zoonotic foodborne pathogens | essay

Zoonoses describe diseases that can be transmitted from vertebrate animals to humans. Zoonotic diseases are common and are caused by various types of agents, such as bacteria, fungi, viruses, or parasites [12]. According to the study by Taylor et al. 2001 that out of the 1415 infectious organisms that are pathogenic to humans 61% of them are zoonotic [8]. And over 200 zoonoses related diseases are known [12]. Zoonoses related diseases can be caught from foodborne zoonoses, non-foodborne zoonoses, helminthic parasitic zoonoses, protozoan parasitic zoonoses and zoonotic ectoparasites. However this work is only focusing on the common bacterial related foodborne zoonoses.

Every year bacterial foodborne zoonoses is the cause of millions of people becoming ill [12]. The most significant bacterial zoonotic pathogens associated with foodborne disease are Campylobacter, Salmonella and Escherichia coli O157: H7 [5]. Other bacterial foodborne zoonotic pathogens are Mycobacteria, Listeria, and Brucella all of which are from dairy products.

The zoonotic foodborne pathogen Campylobacter causes the illness campylobacteriosis which causes often bloody diarrhoea, malaise, fever, nausea, abdominal pain and vomiting. The incubation period is usually between 2-5 days before onset of symptoms. Most Campylobacter infections are mild, without the need for hospitalization and with complete recovery within 10 days. However the severity of the disease varies and in some cases may be life-threatening or resulting in long term health problems. People that tend to die by the disease are often suffering from immuno-deficiencies, or other diseases like liver disease or cancer. Guillain-BarrÑ syndrome (GBS) is a complication of Campylobacter infection that occurs in approximately 1 in every 1000 reported cases of campylobacteriosis (CDC, 2008, May 21). GBS an autoimmune disease that targets the nerves cells of the body may lead to permanent paralysis. Another neurological related syndrome that may occur subsequent to campylobacteriosis is Miller Fisher Syndrome. [2, 5, 10]

In the UK there are approximately 55, 000 cases a year of Campylobacter infection. Campylobacter jejuni being the predominant Campylobacter species that causes foodborne gastrointestinal illnesses in humans, other similar closely related species that causes diseases in humans are C. coli and C. fetus. C. jejuni are curved gram-negative, microaerophilic, thermophilic rods with optimum growth temperature at 40oC and low oxygen concentrations. It is these qualities of C. jejuni that enables it to colonise the intestines of warm-blooded birds and mammals. The reservoir for C. jejuni ranges from healthy domestic and wild animals such as dogs, cats, cattle, pigs, sheep, birds, chickens, rodents, ducks and geese. As C. jejuni is ubiquitous in nature food products particularly poultry meat, beef and pork are at risk of environmental contamination during processing. Campylobacter can survive in livestock water troughs, stock ponds, lakes and dairy lagoons all of which may introduce the infection into the animal flocks. Also rodents, wild birds, faecal contaminated equipment and footwear may all serves as potential vehicles of transmission of bacteria into the animal flocks. Once the infection is introduced into the flock rapid transmission between the animals occur with subsequent colonization of commercial meat that if undercooked may lead to foodborne enteritis in the consumer. Poultry meat tend to carry high bacterial numbers of C. jejuni, being the main source of infection in humans as it has a high level of consumption so the risk is greater. The consumption of unpasteurized milk should also be avoided as it is an identified source of Campylobacter, but pasteurization of dairy products eliminates the pathogen. [2, 5, 10]

Control and prevention measures have been established in order to reduce Campylobacter pathogens entering the human food chain. These control strategies are aimed at preventing colonization of the pathogen in food animals through the implementation of strict bio-security measures, good hygiene practices at harvest level in an attempt to control and minimise the level of faecal contamination during poultry transportation, slaughtering and carcase dressing. Other incorporated control methods include decontamination strategies, rodent control, exclusion of wild animals and insect eradication that are potential carriers of the pathogen, and chlorination of drinking water to 2ppm. Gamma irradiation of animal carcasses is also effective at reducing the colonization levels of the pathogen in the carcass, but this method although endorsed by the World Health Organisation (WHO) and others is not well accepted by consumers. Increased public awareness of foodborne Campylobacter infection is necessary as in the end the only measure to ensure reduce risk is at the consumer level through increased hygiene when storing, preparing and handling raw-meat to avoid cross-contamination via utensils and through adequately cooking of the poultry at recommended temperatures by the Food and Drug Administration (FDA) to ensure destruction of C. jejuni. Undercooked poultry has been responsible for > 50% of cases of C. jejuni. [2, 5, 10]

The second most common bacterial foodborne zoonoses pathogen reported is Salmonella which are gram negative rod-shaped bacteria that are closely related to the Escherichia, and is responsible for causing salmonellosis. Salmonellosis is associated with enteric infections and since the discovery of the first strain of Salmonella in 1885 called Salmonella choleraesuis there have been over 2300 strains known to cause salmonellosis; the most common being S. Enteritidis and S. Typhimurium. In the UK there are approximately 11, 000 cases a year reported on Salmonella which causes gastroenteritis. Symptoms include diarrhoea, abdominal cramps, nausea, vomiting, and fever. In severe cases the diarrhoea may be bloody just like in Campylobacter infections. The incubation period for Salmonella varies from 6 to 72 hours. Complications may also arise such as bacteraemia or Reiter's syndrome. Bacteraemia occurs when the Salmonella pathogen enters the infected individual's bloodstream. Reiter's syndrome although uncommon may result from Salmonella infection, it is a disorder associated with at least two of three seemingly unrelated symptoms: reactive arthritis, eye infection and urinary tract infection. The people most susceptible to contracting Salmonella infection include immuno-compromised individuals such as AID sufferers, cancer patients, or transplant recipients. Or individuals that are in close proximity to other infected people, such as sharing a household, or individuals that possess pet lizards, birds, or reptiles. Salmonella has a low infectious dose, probably from 15-20 cells. [3]

Salmonella are present in the environment as well as cold and warm blooded animals. The Salmonella serotypes in food animal species like poultry can be divided into host specific and non-host specific infections. The host specific infections are those that affect the bird host and are of little public concern, such as S. Gallinarum and S. Pullorum. They are the common serotypes implicated in poultry disease. As for the non-host specific infections they are the cause of Salmonella foodborne poisoning in humans such as S. Enteritidis and S. Typhimurium. Most of the serotypes associated with human foodborne disease cause no disease in poultry, but can be spread by them between flocks and once in the food chain the product is contaminated food. Poultry meat and products like eggs are the main source of Salmonella infection in humans. [3]

Similar to the Campylobacter control strategies, on farm prevention and control methods are undertaken to control Salmonella in poultry. Strict bio-security measures and farm pathogen reduction strategies are the first steps in minimising the occurrence of foodborne pathogens in eggs and meat. Surveillance of poultry flocks for Salmonella should be conducted to identify any infected flock which can then be immediately dealt with using appropriate measures to minimise spread within the flock and the risk of transmission to humans. Infected flock should be slaughtered and disposed of appropriately to reduce human exposure to Salmonella. One of the ways in which poultry may contract Salmonella is through contaminated food, thus it is necessary to monitor the poultry feed status. It is recommended to use bactericidal treatment or heat treated food to prevent Salmonella contamination. Poultry food should also be contained in clean closed containers to prevent access by rodents or wild birds. Rodent control should be used as a repellent. Vaccines against Salmonella can also be used but should not be used as the sole control measure, rather as an additional prevention measure. Good hygiene practices should be used such as cleaning and disinfection of equipment and the bird house, disposal of litter in a safe manner especially contaminated waste to prevent exposure to humans, livestock and wild-life to Salmonella. The use of antimicrobials as a treatment of Salmonella infection in poultry should not be used as it may contribute to the development of antimicrobial resistance, or mask the infection during sampling. Also it is vital that public awareness and education of foodborne Salmonella infection is raised so that poultry consumers can take necessary precautions to avoid contracting the infection. The precautions that consumers can take include the cooking of meat adequately before consuming, cooking of eggs until the yoke is solid, not consuming food containing raw eggs, not consuming unpasteurized milk, and the washing of hands after handling any animals. [7, 10]

The third and last foodborne bacterial disease to be discussed is the gram-negative rod-shaped bacterium Escherichia coli (E. coli) O157: H7. The ‘ O’ and ‘ H’ denotes the cell wall and flagella antigen number respectively. E. coli bacteria colonise the intestinal tract of warm blooded animals, such as humans and mammals. There have been over 700 serotypes identified but those that produce the Shiga toxin (Stx), such as E. coli O157: H7 have been associated with foodborne illnesses and is responsible for most of the E. coli related illnesses in humans. In the UK alone there are approximately 1, 100 cases per year of E. coli O157: H7 with just a small dosage (<100 CFU) required to cause infection. The incubation period of E. coli is between 1-10 days. Infection occurs after the Stx-producing pathogen is ingested through the consumption of contaminated foods. In the intestine the bacteria multiplies and binds to cells lining the intestine where the toxin is then absorbed into small capillaries in the bowel wall and recognises globotriaosylceramide (Gb3) receptors. Hemorrhagic colitis one of the first symptoms of E. coli O157: H7 infection characterized by abdominal pain, cramps, followed by diarrhoea is caused by inflammation as a result of the toxins. The diarrhoea may become watery or bloody during infection progression. Other E. coli symptoms that may be experienced include vomiting and fever, although the latter is uncommon. Complications associated with E. coli O157: H7 infection is haemolytic uremic syndrome (HUS) which is a common cause of acute kidney failure. HUS occurs in about 10% of E. coli cases, during which the Stx enters the systemic circulation and binds weakly to receptors on white blood cells that are carried to the kidneys where they attach to Gb3 receptors. Depending on where the Stx toxin recognises the Gb3 receptors it may result in organ injury. Mostly Gb3 receptors are distributed in the gut and kidneys, but can be also present in other vital organs such as the brain. [4, 6]

The main source of E. coli O157: H7 is in cattle herds colonizing the intestines of healthy cattle as a commensal. Cattle contract the pathogen through environmental sources such as water or manure in feed contaminated with the bacterium. As cattle do not possess the necessary Gb3 receptors required for the Stx to attach and enter the cell they are able to carry the bacteria without any harm, dropping them in their faeces which may spread to humans through contaminated food sources, such as ground beef, salami, unpasteurized milk or cheese, lettuce, spinach, and water. Raw milk can become contaminated from bacteria being present on the equipment or on the animal's udder. Fruits and vegetables may become contaminated by manure from infected cattle. Water can become contaminated through running off fields containing cattle or animal manure. Even unchlorinated swimming pools if used by an infected individual can become contaminated. Once in humans the pathogen is easily transmitted between people, especially amongst infants. [4]

As with most foodborne pathogens control measures and management techniques at the producer level for E. coli O157: H7 has been implemented to minimise the incidence and spread of infection in livestock and to provide safe food products to the public consumers. As E. coli O157: H7 can survive in cattle faeces for up to 100 days and they have high tolerance to various environmental conditions being able to produce Stx when incubated at low or high temperatures it is therefore necessary that manure handling is done appropriately to reduce the spread of E. coli O157: H7. Regular cleaning of cattle food bunks is a necessary management practice in case of faecal contamination of feed to reduce the risk of multiplication of E. coli O157: H7. Also the cleansing of water troughs is another vital practice as cattle consume large quantities of water which is a common source of E. coli O157: H7 contamination. Through feeding management it may be possible to manipulate the proliferation and faecal shedding of E. coli O157: H7 in ruminants, by altering their diet from high-grain ration to high-quality hay-based diets. This method is widely used as a pre-slaughter application to reduce faecal contamination of animals going to slaughter and their microbial load before entering the food chain. Also post-slaughter hygiene practices are crucial in minimizing carcass contamination. Surveillance of cattle for the pathogen is a key step to identifying positive carriers before slaughter. Other potential control measures include the use of irradiation to decontaminate raw meat and vaccines, although as of yet no vaccine has been a successful breakthrough. Lastly public awareness and education is needed for consumers to have kitchen and personal hygiene, taking care in preparing and cooking food to avoid cross contamination, and ensuring proper cooking of food. [1, 11]