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Review on yersiniosis and its public health importance

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Abstract
Yersinia belongs to the Enterobacteriaceae family and is widely found distributed in the environment. Of more significance to food safety is *Y. enterocolitis* very important in a foodborne zoonosis with substantial importance to public health. Enteropathogenic *Yersinia* species can grow at low temperatures, refrigerated foodstuffs can become able to cause contaminations. Swine and wild animals are common reservoirs. *Y. enterocolitica* is primarily a foodborne pathogen found in some food-producing animals such as pigs and other mammals. After ingestion of contaminated water or food, *Y. enterocolitica* colonizes the intestine causing yersiniosis, an acute gastrointestinal condition. *Y. enterocolitica* is a zoonotic disease known to infect humans via ingestion of faeces-contaminated foods (raw and ready-to-eat) and handling undercooked meat, sewage-contaminated water, etc. In humans, the clinical symptoms of yersiniosis appear most commonly as gastrointestinal disturbances, such as enteritis, enterocolitis and gastroenterocolitis accompanied by fever and often severe bloody diarrhoea. Refrain from feeding captive wildlife raw pork/game meat and undercooked chitlins; Staff working with captive wildlife should practise good hand washing after contact with animals but there is no vaccination available or recommended for wildlife as medical prophylaxis.

Keywords: Yersiniosis, zoonosis, public health

Introduction
Yersinia is one of the foodborne pathogen which belongs to the Enterobacteriaceae family and is ubiquitous in the environment [1]. *Yersinia pestis* is the major cause of bubonic plague, which has rare case occurrence. *Y. enterocolitis* is very important pathogen in food safety which is known by causing appendicitis-like symptoms. *Yersinia* is psychrotrophic bacteria that can survive outside of the host environment Similar with *Listeria*. The incidence of *Y. enterocolitica* is low when considered but its high occurrence related with vacuum-packed meats or chilled foods of vegetable origin [2]. The low incidence of *Yersinia* infections can also occur due to the high infectious dose is required and due to lack of selective diagnostic methods. *Y. enterocolitica* and *Y. pseudo tuberculosis* are also noted as psychotropic bacteria, being able to grow at temperatures of 4 °C or even lower. Rodents are the common natural reservoirs of *Yersinia* species; other mammals can occasionally serve as hosts. *Y. pestis* transmitted to humans through flea bites and sometimes become airborne during pandemics. *Yersinia* is enteropathogenic bacteria which has the capacity to grow at low temperatures able contaminate refrigerated foodstuffs. The main reservoirs of Yersinia are Swine and wild animals [2].

Y. enterocolitica is the causative agent of yersiniosis which has a public health importance especially regarding foodborne zoonosis. *Y. enterocolitica* is widespread in the environment and animal populations, posing a potential source of infection in humans. Yersinia enterocolitica can cause agreat food contaminant that is major cause of yersiniosis. 7,017 cases of yersiniosis were confirmed in the European Union in 2011, approximately it was increased by 3.5% when compared with 2010. A total of 257 yersiniosis cases were reported In Poland in 2011 and the percentage of incidence was 0.67 per 100,000 inhabitants. In 2012, the number of confirmed yersiniosis cases decreased to 231, with an incidence rate of 0.6 per 100,000 inhabitants [3]. In Europe Yersinia enterocolitica is the third major causal agent of gastrointestinal manifestations [4]. *Yersinia* can cause a varieties of illnesses in humans like Crohn's disease, yersiniosis, mesenteric lymphadenitis, pseudo appendicitis, and systemic infectious disease, commonly known as plague.

Plague is mainly caused by *Y. pestis* which has been responsible for three human pandemics throughout history. This plagues documented from the sixth to eighth centuries, the ''Black Death'' from the fourteenth to nineteenth centuries, and the modern plague from the nineteenth century to the present time [5].

Y. enterocolitica is the main a foodborne contaminant found in food animals including pigs and other mammals. Once contaminated water or food is consumed, *it* colonizes the intestine causing yersiniosis which cause acute gastrointestinal infection. The main signs of yersiniosis includes fever, abdominal pain, vomiting, and diarrhea. It is mainly treated by continuous course of antimicrobial therapy [6]. *Y. pseudo tuberculosis* is the least common of the three *Yersinia* pathogenic strains. It causes an illness characterized by fever and acute abdominal pain arising from mesenteric lymphadenitis, an inflammation of the lymph nodes [7]. *Y. enterocolitica* is one of three human pathogenic species in the genus *Yersinia*. They are a genus in the family *Enterobacteriaceae*. It can be transmitted by the ingestion of contaminated food products including vegetables, milk products, and meat. The optimum growth temperature of Yersinia is about 30ºC, and it is similar with *Monocytogenes* that can grow at refrigeration temperatures and also survive under the freezing process. The clinical signs of *Y. enterocolitica* infection (yersiniosis) include diarrhoea (which may be bloody in severe cases), mild fever, abdominal pains, and possibly vomiting [8].

The State Sanitary inspection responsible for the supervision of human infectious diseases in Poland constantly monitors the epidemiologic situation, including that of yersiniosis. Due to the fact that yersiniosis is a zoonosis, the State Sanitary Inspection representatives should stay in permanent contact with the State Veterinary Inspection by exchanging information on the current epidemiologic and epizootic situation [9]. According to the World Health Organization, the lack of medical prevention of the disease, sanitary and hygienic conditions in slaughterhouses, and public information campaigns are crucial. Informing and educating society on the need to follow basic hygiene rules, especially in contact with food, is essential in preventing the spread of factors that are the causative agents of gastrointestinal infections, including *Y. enterocolitica*. Yersinia (mainly enterocolitica) can be caused by eating a variety of foods, including milk and milk products, raw meat (beef, pork, chicken, and lamb), poultry, eggs, vegetables, bean sprouts, tofu, seafood, and others [10]. Yersinia are able to reproduce in vacuum-packed foods and at refrigeration temperature. Refrigeration of contaminated foods at manufacturing and consumer sites result Yersinia species that can survive and thrive in food. The increased ingestion of processed foods where in contamination can occur after pasteurization can also potentiate the risk of outbreaks. The spread in the international food trade and changes in livestock farming and the food industry can leads to the occurrence of yersiniosis globally [2]. Therefore the objectives of this paper are to give clue based on the existing research on yersiniosis as a zoonotic foodborne disease and consequently to provide an overview of the role of yersiniosis in public health.

Literature Review

Aetiology

In total, there are 18 species of *Yersinia*, three of which are important human pathogens associated with zoonotic infections; *Y. pestis* causes plague and *Y. pseudo tuberculosis* and *Y. enterocolitica* facilitate the occurrence of yersiniosis. *Y. enterocolitica*; Its source includes animals, especially swine, and entered into the body through ingestion of contaminated food, especially undercooked pork, unpasteurized milk, water Blood transfusion [11]. *Yersinia pestis* can be transmitted to humans subcutaneously through flea bites and can become airborne during pandemics. *Yersinia pseudo tuberculosis* (with subspecies) is associated with intestinal infections and mesenteric lymphadenitis [12].

Source of Infection and Transmission

1. Fecal-oral transmission can also occur through ingestion of contaminated food or water and also through contact with infected people and animals; 2. Wild and domestic animals including pets animals (sick puppies and kittens) and swine are the major reservoirs of *Y. enterocolitica*; 3. Y. pseudo tuberculosis is a zoonotic disease of several types' wild and domestic birds and animals, mainly among rodents and other small mammals such as turkeys, ducks, geese, pigeons, pheasants, and canaries. 4. Humans are accidental hosts of Yersinia infection; 5. *Y. enterocolitica* infection is most often caused by consumption of undercooked meat and pork products; 6.unpasteurized milk or chemically untreated water can also the main source of the infection; 7. Transfusion of blood from infected person who were asymptomatic or direct faecal-oral, person-to-person transmission is also possible; 8. Human carriage take 2-6 weeks, or longer if untreated stay up to 6 months. Long-term carriers are also possible [13; 14].

Food born Transmission

According to outbreak investigations, and historical Netherland studies including a case-control study performed in 1995–1996, identified risk factors that include consumption of pork products, association with backyard slaughter of pigs (possible zoonotic exposure), animal contact, possible person-to-person contact, and contact with untreated water or unarticulated sewage [15]. International studies have reported that pigs are an important reservoir for Y.E and the pathogenic Y.E serotypes that are most frequently found in pigs and pork products are those most commonly reported in human infections [16]. Often YE infections are linked to the consumption of undercooked contaminated pork or cross-contamination of other food items during the handling and preparation of raw pork [17]. Several case-control studies and a systematic review and meta-analysis study by Guillier *et al*., 2019 published internationally to support this observation. However, other food items such as raw milk, pasteurized milk, water, fresh vegetables, and produce have been implicated, suggesting that sources other than pork may also be important [19]. A reduced storage time (under one day) or a storage temperature (below 4^0C) would largely reduce the proportion of packages containing high numbers of pathogenic *Y. enterocolitica* [20].

Waterborne Transmission

Outbreaks of *Y. enterocolitica* has been attributed to the consumption of untreated drinking water internationally [21]. Consumption of water from a home supply increases the risk for intestinal YE infection. This risk factor may be different for urban populations. Rural households may draw their drinking water from the surface, ground, or rainwater sources which are not subject to the same drinking water standards as community water supplies [22] and may be contaminated by animals or birds. Studies internationally have reported the

detection of pathogenic Y.E in environmental waters and untreated water (and sewage) [23].

Human-to-Human Transmission

Yersiniosis is rarely transmitted through sustained person-to-person transmission, but there have been previous *Y. enterocolitica* outbreaks internationally in which a food handler was implicated [24]. A nosocomial outbreak of diarrheal disease due to *Y. enterocolitica* has been reported in Canada. Asymptomatic bacteremia in blood donors has historically led to fatal transfusion outcomes in Netherland. In 1997, it was reported that eight cases of transfusion-associated transmission resulting in five deaths had occurred in Netherland in the preceding five years [25].

Public health impacts of Yersiniosis

Risks to public health

Y. enterocolitica is a zoonotic disease known to infect humans via ingestion of faeces-contaminated foods (raw and ready-to-eat) and handling undercooked meat, sewage-contaminated water, etc. Due to the high prevalence of gastrointestinal illness, it serves as a major food safety concern, especially in low- and middle-income countries. Local or regional public health officials should be notified of clinical cases immediately [26]. If livestock facilities are infected, *Y. enterocolitica* can cause severe economic loss due to decreased thriftiness (meat production, milk production) and mortality. Developing countries are particularly at risk of economic consequences [13].

Clinical signs of yersiniosis

In animals, *Y. enterocolitica* infections are most often asymptomatic; however, in clinical cases, acute or chronic diarrhoea, possibly with blood, and inflammatory lesions in the intestines are noticed. Yersiniosis may also appear as sepsis with suppurative lesions in the internal organs, skin lesions (*i.e.* erythema), arthritis or mesenteric lymphadenitis and reproductive disorders. Research reports indicate that pigs are a predominant reservoir of *Y. enterocolitica* strains pathogenic to humans. In this species, clinical symptoms of yersiniosis are rarely observed, excluding diarrhea, generally seen in young animals up to 8 weeks of age [27]. Companion animals are becoming an increasingly important factor in the epidemiology of *Y. enterocolitica* infections in humans. Dogs thought to be asymptomatic carriers may be affected with enteritis accompanied by weakness, in appetence, bloody diarrhoea, vomiting, arrhythmia, and sometimes jaundice or respiratory disorders, leading to death. Yersiniosis accompanied by gastrointestinal disturbances has also been reported in cats. Cases of familiar epidemic yersiniosis have been recently reported and attributed to very close contact, especially of young children, with infected domestic animals [28]**.** In case of humans, the signs of yersiniosis manifested most commonly as gastrointestinal problems, such as enteritis, enterocolitis and gastroenterocolitis followed by fever and often severe bloody diarrhoea [29]. Vomiting and abdominal pain lasting for 1-3 weeks are also observed. These forms are especially severe in children under 5 years of age and may be sporadic, familial, or epidemic with a varying degree of severity [30; 31].

Diagnosis of Yersiniosis

Clinical diagnosis

The incubation period of *Y. enterocolitica* is between 3-10 days, and the infectious period is usually 2-3 weeks. Clinical signs in wild and domesticated mammals are highly variable and are dependent upon strain and serotype as well as host species (e.g., humans develop the diarrhoeal disease more commonly). Infected animals may present with decreased thriftiness, diarrhea, and dehydration. Livestock is not known to develop clinical signs aside from decreased thriftiness and sudden mortality [32]. *Y. enterocolitica* is an intracellular pathogen that survives within macrophages; infections may persist within lymph nodes and other lymphoid tissue for an extensive period of time. Specific invasion sites and survival times depend on a range of virulence factors. *Y. enterocolitica* produces a heat-stable enterotoxin that causes diarrhoea in mammals, including humans. Lesions of the disease include Muco Haemorrhagic diarrhoea; multifocal hepatic and splenic necrosis; Mesenteric lymphadenopathy; Ulcerative gastroenterocolitis [33].

Differential diagnoses

Salmonellosis, Shigellosis, Appendicitis Clinical manifestations of *Y. enterocolitica* infection include diarrhoea, abdominal pain, fever, and vomiting. However, these clinical features, along with hematologic or biochemical data, do not differentiate the diagnosis of *Yersinia* from other bacterial causes, such as *Salmonella* and *Campylobacter* [34]. Definitive laboratory identification depends on stool culture. *Yersinia* is known to grow poorly on agar commonly used for culturing *Salmonella-Shigella* and *Campylobacter*. Therefore, if there is clinical suspicion, the microbiology laboratory should be reminded to use appropriate selective agar for *Y. enterocolitica* to improve the detection rate [35].

Prevention and Control

Public health measures

Public Education: 1. Undercooked/raw pork meat should not be consumed 2. Only pasteurized milk or milk products should be consumed; 3. Washing of hands with soap and water prior to eating and preparing food, after contact with animals, and after handling raw meat is very basic; 4. Separate cutting boards for meat and other foods should be used independently. All cutting boards, counter-tops, and utensils with soap and hot water after preparing raw meat; 5. Dispose of animal faeces in a sanitary manner [36].

Sanitary and Medical prophylaxis

Refrain from feeding captive wildlife raw pork/game meat and undercooked chitlins; Staff working with captive wildlife should practise good hand washing after contact with animals but there is no vaccination available or recommended for wildlife as medical prophylaxis.

Conclusions and recommendations

The occurrence of yersiniosis as well as its great tendency to cause zoonotic infections, make this disease a continuous challenge and a subject of investigation by several research groups justifying the continued attention in this area. Independently from the origin of the infection, yersiniosis has been shown to be important in public health and therefore may play a role as the cause of zoonotic infection. It is known that much investigation is required to specify the problem of Yersinia in public health, especially in Ethiopia and the way to control it. The role of Yersinia in zoonotic infections is crucial to determine and study the best control strategies to be used in veterinary practice in order to reduce zoonotic infections and ensure food safety and quality.

So based on this, the following recommendations are indicated

- The research gap regarding yersiniosis in public health requires special attention, especially in Ethiopia to divert the problems of Yersinia in foodstuff.
- Specific and clear strategies to control the yersiniosis infection still require further studies.
- Regular monitoring of food safety and sanitation be enhanced to promote the prevention of the problem.

List of abbreviations

- ECDC: European Centre for Disease Prevention and Control
- YE: Yersinia enterocolitica
- CDC: Center of disease control
- BIOHAZ: Biological Hazards
- WHO: World Health Organization

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