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Food Related Parasitic Infection: A Review

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Abstract

Food safety, regardless of the specific food product, should be of paramount concern to everyone. All countries need to ensure that national food supplies are safe, of good quality and available in adequate amounts at affordable prices to safeguard good nutrition and health for all population groups. Parasitic diseases represent one potential health risk. The incidence of food-borne diseases continues to adversely affect the health and productivity of populations in most countries. However, food-borne infections have become of increasing concern to governments and the food industry. Improvements in international transportation means food can be distributed throughout the world, but so can the parasitic pathogens which contaminate foods. Alternatively, tourists are being affected abroad and possibly transmitting the pathogen to others at home. Thus, an increasing number of food-related illnesses are international in scope. In this review parasitic contamination of foods of animal origin, particularly meat and fish will be discussed together with potential problems associated with water and unwashed fruits and vegetables from foods.

Keywords

Food Borne Parasites, Intestinal Parasitic Infections, Vegetables, Meat, Fish

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1. General Knowledge

The World Health Organization (WHO) categories parasites among the six most harmful infective diseases of man and parasitic infections outrank cancer as the number one killer in the world. Parasites can be contracted by eating contaminated under-cooked beef, pork, fish or other flesh foods, eating unclean raw fruits and vegetables or drinking infected water [1].

Parasites may be present in food or in water and can be identified as causes of food-borne or waterborne illness. Numerous parasites can be transmitted by food including many protozoa and helminthes. There are about 107 known species of parasites that can be food-borne. In the United States, the most common food-borne parasites are protozoa such as *Cryptosporidium* spp., *Giardia intestinalis*, *Cyclospora cayetanensis*, and *Toxoplasma gondii*; roundworms such as *Trichinella* spp. and *Anisakis* spp.; and tapeworms such as *Diphyllobothrium* spp. and *Taenia* spp. A wide variety of helminthic roundworms, tapeworms, and flukes are transmitted in foods such as (undercooked fish, crabs, and mollusks; undercooked meat; raw aquatic plants such as watercress and raw vegetables that have been contaminated by human or animal feces). Some foods are contaminated by food service workers who practice poor hygiene or who work in unsanitary facilities. Symptoms of food-borne parasitic infections vary greatly depending on the type of parasite. Protozoa such as *Cryptosporidium* spp., *Giardia intestinalis*, and *Cyclospora cayetanensis* most commonly cause diarrhea and other gastrointestinal symptoms. Helminthic infections can cause abdominal pain,

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diarrhea, muscle pain, cough, skin lesions, malnutrition, weight loss, neurological and many other symptoms depending on the particular organism and burden of infection. Treatment is available for most of the food-borne parasitic organisms [2]. Statistics on food-borne illnesses due to parasitic infections have been difficult to estimate. Stoll [3] estimated that in the global population of 2.2 billion people, there were 664 million *Ascaris lumbricoides* infections (30% prevalence) and 355 million infections with *Trichuris trichiura* (16%) compared to the update by Michael et al. [4] which estimated 1273 million (24%) and 902 million (17%) infections 50 years later when the human population was 5.6 billion. However, their overall impact as demonstrated by substantial incidences of food-borne *Trematodes* infections (*Opistorchis*, *Clonorchis*) in Southeast Asia and the Pacific region [5] underscores the need for increased awareness of this class of human pathogens, particularly with the consumption of raw or undercooked seafood. In the U.S., the latest survey of food-borne illnesses by the Centers for Disease Control and Prevention estimates that there are 2.5 million cases annually due to food- and beverage-borne parasites [6].

However, the parasite *Toxoplasma gondii*, coccidian protozoa, is responsible for 20.7% of food-borne deaths due to known infectious agents. The flagellated protozoa, *Giardia lamblia* intestinalis, causes the greatest number of parasite-related disease cases, with an estimated 2,000,000 illnesses annually, equaling 1.4% of the food- and beverage-borne total for known pathogenic agents. *Cryptosporidium parvum* is reported to cause 30,000 cases (0.2%) and the recently recognized *Cyclospora cayetanensis* caused 14,638 cases (0.1%), due primarily to imported fresh produce. Although it is difficult to distinguish food-borne from waterborne illnesses attributed to these species, their impact on food safety and public health both nationally and internationally appears to be significant [7]. The relationship between enteric parasitic protozoa, the environment, contamination of food, and human illness is extremely complex. Environmental factors play a significant role in the transmission of most food-borne parasitic diseases. This impact is particularly apparent with protozoa, which are readily transported to food by contaminated water [8]. Fecal contamination of water sources used in crop irrigation, food processing and meal preparation are important sources of human infection. In this regard, contamination of fresh fruits and vegetables is causing the greatest concern. These commodities are intimately influenced by the environment and agricultural practices, and often receive no processing that is lethal to protozoa.

2. Scientific Background

Food-borne illnesses caused by parasites are prevalent in all parts of the world usually causes nausea and vomiting, diarrhea, abdominal cramps and fever may lead to more serious complications or even death. Over recent decades, parasitic protozoa have been recognized as having great potential to cause water-borne and food-borne disease. The organisms of greatest concern in food production worldwide are *Cryptosporidium*, *Cyclospora*, *Giardia*, and *Toxoplasma*. Although other parasitic protozoa can be spread by food or water, current epidemiological evidence suggests that these four present the largest risks. The major modes of transmission of protozoa include consumption of water, exposure to contaminated water, animal-to-person contact and person-to-person contact [9]. However, the epidemiology of protozoa most commonly associated with human infections, namely *Giardia*, *Entamoeba*, *Toxoplasma*, *Sarcocystis*, *Isopora*, *Cryptosporidium*, *Eimeria* and *Cyclospora*, is not fully understood [10]. While the life cycles of each of these parasites differ, all require passage through an animal or human host. Shedding of cysts or spores into feces which may then, directly or indirectly (e.g. via sewage or irrigation water), contaminate raw fruits and vegetables occurs on a global scale. Cyclosporiasis; *Cyclospora* in basil [11] Cayetanensis; *Raspberries* [12] dessert [13] Diphyllobothriasis; *Diphyllobothrium* in salmon [14] Fascioliasis; *Fasciola hepatica* in lettuce [15] Giardiasis; *Giardia lamblia* in raw sliced vegetables [16] Fruit salad [17] Nanophyetiasis; *Nanophyetus* in salmonid fish [18] Salmincola Trichinellosis; *Trichinella* in horse meat [19], cougar jerky [20]. Outbreaks of protozoan infections in humans have been linked to raw fruits and vegetables. Epidemiological evidence has implicated an asymptomatic food handler as the probable source of *Giardia lamblia* and raw sliced vegetables as the vehicle of transmission in an outbreak of *Giardiasis* [16]. Raspberries [21-23], lettuce [22], and basil [24] have been the implicated vehicles of transmission in outbreaks of *Cyclospora cayetanensis* infection, and unpasteurized apple juice has been linked to outbreaks of cryptosporidiosis caused by *Cryptosporidium parvum* [25].

A survey of vegetables has revealed the presence of *Cryptosporidium* oocysts on cilantro, lettuce, radish, tomato, cucumber and carrot [26]. The presence of these protozoa on raw fruits and vegetables is likely to be due to contact with animal or human feces, sewage, water containing untreated sewage and sludge from primary or secondary municipal water treatment facilities. While *Cryptosporidium*, *Giardia* and other parasites in water are quite resistant to chlorine and other disinfectants, little is known about the efficacy of these disinfectants in killing or removing parasites from the surface or tissues of fruits and vegetables. Surveys have shown that there is a high incidence of the parasitic roundworm,

Ascraris, in the sewage sludge of many cities [23].

Intestinal parasitic infections are widely distributed throughout the world causing substantial intimidation to the public health, economy, and physical and cognitive development particularly among children in developing countries. The poor personal hygiene, poor environmental hygiene, and poor health system commonly observed in developing countries make the prevalence to be highest among these populations [27, 28]. The consumption of fruits and vegetables helps in protecting human body from a number of diseases by providing nutrients, vitamins, minerals, protein, and fibers. It could also have a positive impact on body-weight regulation and related conditions, including diabetes and hypertension. However, fruits and vegetables, especially, those that are consumed raw and or not properly washed, have been the major way for the transmission of human pathogens [29-31]. Intestinal parasitic infection may be acquired in different ways like by consumption of contaminated fruits, vegetables, other food stuff, and water [32]. Eating unclean, raw, or undercooked fruits and vegetables is one of the means by which the transmission of intestinal parasitic infections is propagated [33]. Fruits and vegetables act as vehicles for the transmission of parasitic infections when contaminated as a result of various associated factors related to planting, such as while they are still on the field, harvesting, transportation, storage, market chain, and even at home [31, 34].

Food-borne *Trematodes* infections are major health problems, with an estimated 40 million persons, mainly in eastern and southern Asia, being affected [35]. Infection takes place through the consumption of raw plants, or undercooked freshwater fish or shellfish, containing the infective cyst (metacercaria) stage of these parasites. Watercress is a major source of *Fasciola hepatica* infection [5]. Over 300,000 clinical cases of fascioliasis may have occurred in more than 55 countries in Africa, the Americas, Asia, Europe and the western Pacific from 1970 to 1990 [36]. Large endemic areas have been reported more recently in Bolivia, Egypt, Iran and Peru [35].

A wide range of other aquatic plants may support metacercariae. Conditions for transmission of *Fasciolopsis buski* are present in areas of cultivation of water caltrop, water chestnut, water hyacinth, water bamboo, water mimosa, lotus and duckweed. If animal manure or effluent from livestock pens or abattoirs is used as fertilizer for these plants, it introduces *Fasciolopsis* to the aquatic environment. Plant borne *Trematodes* encyst as metacerceriae on the surface of plants or on debris floating on the water surface. Plants that grow in water are also believed to serve as hosts for encystment of metacercariae of certain intestinal flukes [5]. Non aquatic plants such as lettuce, alfalfa, mint and sugarcane which may be eaten raw have also been implicated in human trematodes infections. For example, more than one billion people are infected with the largest intestinal nematode (*Ascaris lumbricoides*) [37]. In addition to intestinal transmission of *Fascioliasis* which has been increasingly reported from rural Egypt since the late seventies [5, 38, 39]. Moreover, outbreak of protozoan infections in humans has been linked to raw fruits and vegetables [16].

3. Contamination of Meat with Tapeworms

The cosmopolitan distribution of *Taenia saginata,* the beef tapeworm, is due to the practice of eating beef which is raw or under-cooked and there is an estimated 45 million cases world-wide. In this way, infective cysticercus larvae (about 8 mm in length) found in the muscles of cows is ingested. Once ingested, the larvae evert their hooked scoleces, attach and grow. The adult tapeworms are located in the ileum with their scolex (head end) embedded in the mucosa and the rest of the organism, up to 5 m in length, hanging free in the lumen. Posterior segments (proglottides) filled with eggs are passed out with the faeces. The eggs once ingested by cattle hatch to release hexacanth larvae in the duodenum. The larvae penetrate the gut wall and reachvoluntarymuscles via the blood stream and within 10-12 weeks transform into the infective cysticercus larvae in the muscle [40]. Once man ingests the under cooked or raw beef muscle the whole life cycle begins again. *Taenia sohunt*is the pork tapeworm and is less widely distributed than *T. Saginata* with an estimated 3 million cases. *T. solium* is very similar in morphology and life-cycle characteristics to *T. saginata* and man are the only definitive host for both species. *T. solium* is found where pork and pork products are eaten raw or under-cooked. Effective meat inspection should remove infected carcasses from the human food chain, but if the levels of infection are relatively low, the infection might be missed. However, in many countries, none of these measures are in place and tapeworm infections are common. Even in Britain there has been an increase in *T. saginata* cases recently, although *T. solium* does not appear to be a problem. There is little riskif meat is thoroughly cooked or subject to prolonged deep freeze storage.

4. Contamination of Meat with Tissue Nematodes

Trichinellosis, caused by *Trichinella sptrahs,* is a cosmopolitan disease, which has very low vertebrate host

specificity. Short-lived adult infections in the small intestine of a wide range of carnivorous and omnivorous mammals give rise to a large number of invasive larvae (2000/female) which migrate via the blood stream to voluntary muscles throughout the bodies of the host animal. Once in the muscle they encyst. The cysts are the infective stages that can be transmitted to any new host when the flesh is eaten. Human infection is contracted by eating raw or under-cooked pork or pork products containing encysted larvae. Domestic pigs provide the main source of human infections in all areas except Africa where the wild boar, bears, bush pigs or warthogs transmit the disease and in the far north among the Eskimos where polar bears are most important. In the recent international commission on *Trichinellosis* country status report (1995-97), 10,000 cases of trichinellosis were reported world-wide, of which 167 were in Western Europe and 7213were in Eastern Europe. In addition, Switzerland and Norway revealed *Trichinella* infections in foxes (1.3% and 7.5%, respectively) but no infections in domestic pigs. Identification of *Trichinella* in wild animals is important as they may act as reservoir hosts [41]. The adult *T. spiralis* is a small worm living partially embedded in the mucosa of the lleum, where it gives rise to some gut damage. However, important pathology occurs when the larvae migrate to and encyst in the muscles, when m heavy infections a diverse range of symptoms from vomiting and diarrhoea to high fever and muscle pain appear.

5. Conclusion

This study includes several objectives to achieve highlight the prevalence and types of parasites carried by foods. Also, recognizing the problem that parasites are among the dominant public health concerns in several nations and can cause disease outbreaks that encompass entire communities and underscores the need for increased awareness of this class of human pathogens. Although vegetables transmitted-parasites remain a major public health concern in many parts of the world, particularly the poorest developing countries, these findings may have important implications for global food safety and emphasize the importance of raw vegetables in threatening public health by transmission of intestinal parasites to humans. The local health and environmental authorities should improve the sanitary conditions in the areas where the vegetables are cultivated and consumed. Proper treatment of wastewater used for irrigation of vegetables should be implemented. There is also dire need for the improvement of sanitary facilities in our markets and vegetable vendors. Media programs should inform the consumers the potential health consequences of the intestinal parasites through consumption of raw vegetables, and the importance of proper washing and disinfecting of vegetables before consumption. In addition, they should focus on the necessity of good sanitation hygiene and risks of acquiring intestinal parasites.

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