Cyclosporiasis: Enteric Parasitic Illness

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Abstract

Cyclosporiasis is a waterborne and foodborne illness brought on by a coccidian parasite that invades tissue and is associated with enteritis in both immunocompromised and immunocompetent hosts. Its globally emerging disease, with a higher prevalence in developing countries, is commonly linked to eating fresh food that has been contaminated. The coccidian *Cyclospora* is obligatory intracellular parasite and infects the epithelial cells of the upper small intestine. Humans seem to be the only natural hosts for *Cyclospora cayetanensis* that species associated with protracted diarrhea in people of any age. Other described *Cyclospora* species from various hosts are generally host-specific. The *Cyclospora* oocysts found in recently expelled stool are not contagious. As a result, it is unlikely that fecal contamination will directly spread the disease from person to person. Exposure to feces-contaminated food, drink, or soil with sporulated oocysts is the main way that the disease is spread. The existence of animals as a natural reservoir is not confirmed. Infected people with cyclosporiasis typically develop diarrhea as a clinical symptom. The recommended antibiotic for treating *Cyclospora* infection is trimetoprim-sulfamethoxazole. Despite its prevalence in underdeveloped countries, the epidemiological aspects of human cyclosporiasis are little understood, underscoring the need to investigate risk factors and the mode of parasite transmission. To establish appropriate control and prevention measures. More research is needed to better understand the biology and epidemiology of this parasite infection.

Keywords: Cyclosporiasis, *Cyclospora cayetanensis*, Enteric protozoa, Coccidian parasite

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Introduction

Cyclosporiasis is a prevalent illness in tropical and sub-tropical regions and contributes to traveler's diarrhea (Yadav et al., 2015). Coccidian *Cyclospora* is an obligatory intracellular apicomplexan protozoon that inhabits the bile ducts or upper small intestine's mucosal epithelium of several vertebrate hosts (Lainson, 2005), the *C. glomericola* is the only *Cyclospora* species that was found in millipede invertebrates by Aimé Schneider in 1881 (Ortega & Sanchez, 2010). It has been established that *Cyclospora* species are among the most significant intestinal infections that cause chronic diarrhea in both humans and animals (Zhao et al., 2013).

The first human cyclosporiasis report was released in 1979 (Ashford, 1979; Zhang et al., 2021). Over 56 countries worldwide have reported cases of human infection by *C. cayetanensis*, and 13 of those have seen outbreaks of cyclosporiasis (Li et al., 2020a). There have been reports of up to 41.6% infection rates in the general community (Chacín-Bonilla & Barrios, 2011). Foreign residents and visitors to endemic regions are more vulnerable to acute illness and are at a higher risk of contracting it than the indigenous population, including children (Fryau et al., 1999). Even though the majority of immunocompetent individuals often have self-limiting symptoms, it may appear as severe, prolonged, or chronic diarrhea in other situations in immunocompromised patients it may colonize extra-intestinal organs (Almeria et al., 2019).

The main transmission mode of *Cyclospora* infection is through contaminated food (Butler et al., 2015). The primary cause of sickness is contaminated fresh food, such as berries and leafy greens, which are hard to clean effectively and are eaten without being processed further to eliminate or inactivate the oocysts (Dawson, 2005). Up to date, 22 *Cyclospora* species have been identified (Li et al., 2020b). The evidence that is now available implies that *C. cayetanensis* specifically inhabits humans. However, *Cyclospora*-like oocysts resembling C. *cayetanensis* was observed in the feces of various animal species including ducks (Zerpa et al., 1995), chickens (Garcı´a-Lo´pez et al., 1996), monkeys (Smith et al., 1996), dogs (Yai et al., 1997), mice and rats (Sherchand & Cross, 2001), reptiles, insectivores, snakes, and rodents (Lainson, 2005), in cattle (Xiao et al., 2007), and goats (Romero-Castañón et al., 2008), also in zoo animals (non-human primates and artiodactyla) (Pe´rez Cordo´et al., 2008) and in red pandas (Lama et al., 2015).

According to results from the small subunit ribosomal RNA sequence analysis, *Cyclospora* species exhibited a high degree of host specificity (Cama & Ortega, 2024). The only known *Cyclospora* species that may infect humans is *Cyclospora cayetanensis* (Totton et al., 2021). The failure to infect a variety of animal species with *C. cayetanensis* suggests host specificity (Eberhard et al., 2000), and the existence of oocysts that resemble *Cyclospora* oocysts in some animals' feces could just indicate that the organism passed through the digestive system without causing any tissue infection (Ortega & Sherchand, 2015).

Numerous cyclosporiasis epidemics have been documented among emigrants residing in developing nations like Indonesia and Nepal. The vast majority of *Cyclospora* infection cases reported in Australia and Europe have been contracted by tourists in areas where the parasite is

endemic (Ortega & Sanchez, 2010). The latest large-scale cyclosporiasis epidemics happened in several US states in 2013 and 2018 (Abanyie et al., 2015; Casillas et al., 2018). Probably, global climatic conditions such as temperature, humidity, and rainfall have an impact on the seasonality of human *Cyclospora* infections (Zhao et al., 2013). Human infections with *C. cayetanensis* are thought to be mostly caused by environmental causes, including contaminated fruits, vegetables, water, and soil (Onstad et al., 2019). Animals might potentially serve as paratenic hosts for *C. cayetanensis* oocysts by mechanical dissemination, resulting in contamination of water supplies and food, leading to the possibility of human infection (Totton et al., 2021).

Cyclospora spp. primarily infects the epithelial cells of the upper portion of the small intestine, particularly the jejunum (Shields & Olson, 2003). Cyclosporiasis-related watery diarrhea can be delayed for weeks or months, and in small children and immunocompromised individuals, the symptoms could be more serious (Totton et al., 2021). Higher incidence is typically seen in immunocompromised people with diseases like acute lymphoblastic leukemia and Hodgkin's lymphoma (Helmy et al., 2006). While *Cyclospora* infections can be cured with trimethoprim and sulfamethoxazole, those who do not receive therapy may experience recurrent episodes of disease for weeks or months (Herwaldt, 2000). *Cyclospora* spp. can be identified by using hot-safranin and acid-fast staining methods (Ghimire et al., 2008). In addition, an oocyst DNA extraction and PCR assay is a useful technique for the identification of cyclosporiasis (Lalonde & Gajadhar, 2008).

Cyclospora has been shown to be resistant to sanitizers, disinfectants, and insecticides (Ortega-Pierres et al., 2009) including chlorine and iodine. The resilience of *Cyclospora* oocysts to common disinfectants used in the food industry may be attributed to their strong ability to adhere to fruit and vegetable surfaces. Although oocysts cannot survive freezing or drying out. As well as the cooking procedures that raise the product's temperature to 70 °C inactivate the organism (Lawley et al., 2008).

History

In 1870, Eimer discovered *Cyclospora* in the intestines of moles for the first time (Marshall et al., 1997). The organism was believed to be a type of blue-green algae and was referred to “cyanobacterium-like body” or a large form of *Cryptosporidium* or coccidia-like body (CLB) (Mansfield & Gajadhar, 2004). In 1881 Schneider observed *C. glomericola* in millipedes and named the genus *Cyclospora* (Lainson, 2005).

Subsequently, other animals, such as snakes and rodents, were found to harbor the organism (Marshall et al., 1997). During 1977 and 1978, human cases of coccidian-like oocysts that resembled *Cyclospora* were initially documented in Papua New Guinea (Ashford, 1979). The organism was later named *Cyclospora cayetanensis* according to its classical morphology (Ortega et al. 1993). In 1992, it was fully defined and categorized as a coccidian under the phylum Apicomplexa (Tzipori & Jaskiewicz, 2017).

Classification

Cyclospora spp. belongs to the Domain Eukaryota, Subkingdom Protozoa, Superphylum Alveolata, Phylum Apicomplexa, Class Coccidia, Subclass Coccidiasina, Order Eucoccidiorida, Suborder Eimeriorina, Family Eimeriidae, Genus *Cyclospora*, Species *cayetanensis* (Shields & Olson, 2003; Cama & Ortega, 2024). Other species of *Cyclospora* have been identified in non-human primates (Eberhard et al., 2014). The nonhuman *Cyclospora* species in other primates: for example, *Cyclospora cercopitheci*, *Cyclospora colobi*, and *Cyclospora papionis*, are host–specific. Despite being morphologically identical to *C. cayetanensis*, a molecular study of the 18S rRNA gene revealed diversity among them (Tzipori & Jaskiewicz, 2017). Moreover, it is unclear if nonhuman primate *Cyclospora* spp. infects humans, their presence in the environment remains a public health problem (Li et al., 2011).

According to molecular phylogenetic research using the 18S rRNA gene, *Eimeria* species and human-associated *Cyclospora* are closely related (Relman et al., 1996), particularly the mammalian *Eimeria* species (Pieniazek & Herwaldt, 1997).

In the family Eimeriidae there are sixteen genera which are identified by the number of sporozoites and sporocysts within the oocysts. The oocysts of *Eimeria* have four sporocysts, while those of *Cyclospora* have two. Two sporozoites per sporocyst are found in both genera producing eight sporozoites in an *Eimeria* oocyst and four sporozoites in a *Cyclospora* oocyst (Adams et al., 2014).

Morphological Description

The cystic stage of *Cyclospora* parasites in fresh, non-preserved stools, appears as a hyaline, non-refractile cyst under light microscopy (Ortega et al., 1993). It is spherical, with a diameter of 8.6µm (range: 7.7–9.9µm), and it does not sporulate when expelled (Cama & Ortega, 2024). The oocysts' walls are 50nm thick, and their outer layer is bilayer and thread-like (Dixon et al., 2005). The wall is colorless, and a central, undivided mass known as the sporont is enclosed by the inner layer; it nearly fills the oocyst and is 6 to 7µm in diameter, with a cluster of 2µm-wide globules that contain transparent substances that look like lipid (Ortega et al., 1994).

The oocysts can be confused with fecal yeasts since they are passed unsporulated. They are undergoing sporulation depending on the environmental conditions at 23 to 30°C in 1 or 2 weeks (Connor et al., 1999). The morula splits into two ovoid structures known as sporocysts measuring 4.0 by 6.3µm (Cama & Ortega, 2024). The sporocysts contain two folded elongated sporozoites measuring 1.2 by 9µm, with a membrane-bound nucleus and micronemes (Strausbaugh & Herwaldt, 2000). There is a polar body and oocyst residuum in addition to stieda and substieda bodies. The plug-like Stieda bodies are involved in the excystation of sporozoites (Dubey et al., 2020b).

The intracellular phase exhibit four asexual stages: sporozoite, trophozoite, schizont, and merozoite (Sun et al., 1996). The Immature schizonts, also known as uninuclear trophozoites, have a diameter of 2 to 3µm via ectomerogony, or budding, yields the asexual type I and II meronts (Ortega et al, 1997). Each Type I meront had 8–12 tiny merozoites that were 3–4µm long, while each Type II meront had four merozoites that were 12–15µm long (Dubey et al., 2020a). The mature schizonts had up to 10 merozoites and measured 7.6 × 5.1µm (Dubey et al., 2022). Merozoites are 5–6µm length, banana-shaped, and have a nucleus in the posterior third (Nhieu et al., 1996).

Cyclospora cayetanensis sexual stages take place in the same area as schizonts and are smaller than 10µm. The male microgamonts measuring 6.6 × 5.2µm have less than 20 microgametes arranged around a residual body, and the microgametes can be up to 2µm length and flagellated. Female macrogametes have eosinophilic wall-forming bodies that vary in size and are lesser than 1µm in HE-stained sections, and the macrogamonts are approximately 5.8-6.5 x 5.3-6.5µm (Dubey et al., 2020a).

The oocyst of *Cyclospora* has the ability to complete sporulation in 2.5% potassium dichromate within 7–13 days at 25 or 32°C (Ortega et al., 1998). Oocysts are excysted when exposed to 0.5% trypsin and 1.5% sodium taurocholate in phosphate-buffered saline, after then, mechanical disruption occurs (Ortega et al., 1993). However, they lose their capacity to sporulate after being exposed to -20°C for 24 hours or 60°C for 1 hour (Smith et al., 1997).

In addition to being stained with MZN acid-fast stain, some oocysts may exhibit varied staining, such as being unstained, dark red, or pale pink (Connor et al., 1999). When the slides were heated in a microwave or in a water bath for five minutes at 85°C during the staining process, better results were seen. It is possible to confuse the *Cyclospora* oocyst with *Cryptosporidium* and *Cystoisospora* (Connor et al., 1999). However, there is a range of sizes, about one-third smaller than *Cystoisospora* and nearly twice as large as *Cryptosporidium*, *Cyclospora* oocysts have a diameter of 8 to 10µm (Soave, 1996; Gumbo et al., 1997).

Transmission

The *Cyclospora* oocysts are shed unsporulated in freshly expelled feces from diseased individuals, this can take one to several weeks to completely sporulate and become infectious (Lalonde & Gajadhar, 2008). So direct transfer from person to person is improbable. Consuming mature oocysts from contaminated food or water can infect humans (Slifko et al., 2000). Thus, the main way of transmission is by ingestion of sporulated oocysts. Infections are mostly linked to outbreaks that occur after consuming foods like basil, salads, and raspberries (Herwaldt, 2000; Ho et al., 2000). Using fecally contaminated water for irrigating food supplies is the probable mode of transmission (Mota et al., 2000). Oocysts are difficult to eliminate from vegetables and fruits through washing. Although the infectious dose is unclear, it is supposed to be modest (Sterling & Ortega, 1999).

Oocyst transmission has also been documented via soil, arthropod vectors, and domestic animals (Ghimire & Sherchan, 2006). Although the exact role of animals is unknown, it's unclear how animals contribute to the epidemiology of cyclosporiasis (Totton et al., 2021). The only known human-infecting *Cyclospora* species is *C. cayetanensis* (Li et al., 2015). Other animals' excrement contains *C. cayetanensis* oocysts. However, oocysts in animal feces do not always signify infection. Perhaps because animals can serve as paratenic hosts, can help oocysts spread across the environment (Almeria et al., 2019).

Cyclospora infection is typically seasonal, infection rates will rise significantly during the summer or rainy season (Yang et al., 2023). Compared to the dry and warmer seasons, the rainy and cooler seasons in tropical regions offer more ideal circumstances for oocyst sporulation (Herwaldt, 2000).

Life Cycle

Cyclospora's life cycle has not been thoroughly explained. The only stage with a definite identification is the oocyst (Velásquez et al., 2004). Infection is initiated via consumption of oocysts with contaminated food and water (Dubey et al., 2022). After being consumed, sporulated oocysts excyst in the small intestine's lumen, sporozoites are released and enter the epithelial cells. Within the enterocytes, asexual replication occurs. The sporozoites undergo maturation, giving rise to a schizont containing merozoites. Merozoites extruded into the intestinal lumen and invaded new epithelial cells (Sterling & Ortega, 1999).

In the sexual reproduction cycle, flagellated microgemetes found in male microgamonts fertilize macrogamonts to create the zygote (Almeria et al., 2020). Both asexual and sexual reproductive forms occur within an apical intracytoplasmic parasitophorous vacuole in the small intestine's enterocytes (Sterling & Ortega, 1999). Oocysts are released unsporulated in the feces to the exterior environment (Figure 1) (Connor et al., 1999; Scorza & Lappin, 2021).

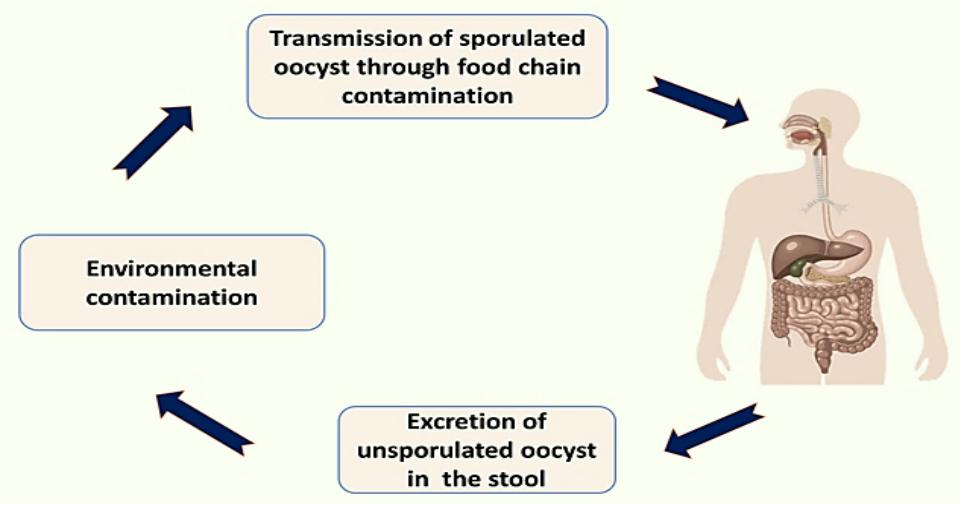

Fig. 1: Life cycle of *Cyclospora cayetanensis*

Pathogenesis

According to histological analyses of small intestine biopsies taken from individuals shedding *C. cayetanensis*, the organism is an intracellular pathogen that causes inflammatory alterations in the lamina propria, mucosa, and epithelium, it may also result in crypt hyperplasia and villous atrophy (Soave, 1996).

Additional modifications include reactive hyperemia brought on by vascular dilatation and villous capillary congestion (Connor et al., 1999). The lymphocytic infiltration is most noticeable near the villous tip and occurs throughout the epithelium. These inflammatory cells push out the epithelial cells' nuclei, causing the cells to lose their natural polarity and change from columnar to cuboidal in shape along the superficial brush boundary. As a result of diffuse edema and the infiltration of mixed inflammatory cells, including lymphocytes, eosinophils, and plasma cells, the intestinal villi may shorten and broaden, changing the mucosal architecture overall (Ortega et al., 1997).

A lot of myelin-like material (MLM) is present between enterocytes as well as along the villus's sides and apices. Although the exact nature and importance of MLM's presence in the intestinal epithelium unclear, when *Cyclospora* infections are occurs, it is frequently observed in other protozoal infections of the upper gastrointestinal tract and could indicate cell damage (Connor et al., 1999). The sporozoites have the potential to infiltrate the gallbladder and bile duct epithelium (Ortega et al., 1997).

Symptoms

Cyclospora spp. is an opportunistic pathogenic parasite (Ortega et al., 1997). *C. cayetanensis* can infect immune-competent individuals of all ages (Madico et al., 1997). The host's immune system determines the clinical signs of the *Cyclospora* infection (Insulander et al., 2010).

Typically, cyclosporiasis incubation period takes 2–22 days (Field, 2002). In people with normal immunity, *Cyclospora* infection manifests as self-limited diarrhea or an inapparent infection. However, prolonged diarrhea can occur in those with immunological deficiencies (Ortega et al., 1997). Adult infected individuals may exhibit asymptomatic course progression or a self-limited condition marked by cyclical, non-bloody, watery diarrhea that occasionally alternates with constipation (Zerpa et al., 1995).

Patients may also exhibit other signs of anorexia, nausea, vomiting, weight loss, exhaustion, and cramping in the abdomen. Before the diarrhea starts, a "flu-like" prodrome with arthralgias and myalgias may appear (Soave, 1996). Sometimes there might be a low-grade fever and symptoms of D-xylose malabsorption (Connor et al., 1999).

Symptoms are frequently persistent and may return month's later (Herwaldt et al., 2000). With each consecutive infection after the first episode of cyclosporiasis, the probability of diarrhea and the duration of clinical signs considerably declines (Bern et al., 2002). In endemic regions, high proportions of asymptomatic carriers have been observed (Bhandari et al., 2015).

Cyclosporiasis has been seen as an opportunistic infection in individuals with HIV (Mota et al., 2000). Prolonged diarrhea, wasting, and weight loss are symptoms of *C. cayetanesis* in HIV-positive individuals (Field, 2002).

There is evidence linking *Cyclospora* infections to Guillain-Barré syndrome and Reiter syndrome, which are characterized by the triad of ocular inflammation (conjunctivitis, iritis, episcleritis), furthermore, sterile urethritis and inflammatory oligoarthritis have been identified as a complication of Cyclosporiasis (Quintero-Betancourt et al., 2002). Biliary illness, as well as co-infections with other intestinal pathogens, including *Cryptosporidium*, have been documented (Ortega & Sanchez, 2010)

Diagnosis

Clinical diagnosis relies on clinical symptoms and slandered laboratory techniques, such as microscopic examinations of wet smears, staining procedures, fluorescence microscopy, serological techniques, or DNA testing for oocysts in stool samples (Li et al., 2020a).

The conventional technique for identifying *Cyclospora*-like oocysts in fecal samples involves microscopic examination (Eberhard et al., 1997). Wet-mount analyses of the concentrated stool material using light microscopy revealed non-refractile spheres with a cluster of refractile, membrane-bound globules, confirming the presence of *C. cayetanensis* (Ydave et al., 2015). The easiest way to confirm a *Cyclospora* diagnosis is to observe oocyst sporulation in potassium dichromate solution after two or three weeks (Eberhard et al., 1997).

The oocysts of *Cyclospora* from stool samples are easily recognized under phase-contrast microscopy, an alga-like morula appearance exhibited in fresh specimens. Using a modified trichrome technique, oocysts fluoresce and stain positively, also stain variable acid-fast using modified Ziehl-Neelsen stain (Xiao, 2009), and modified kinyoun's stain (Ydave et al., 2015).

C. cayetanenesis exhibits significant diversity in staining with acid-fast techniques. It commonly stains from bright red to pale pink, but occasionally it doesn't stain at all, along with changing color, acid-fast stains can cause the oocyst wall to seem wrinkled, crinkled, or collapsed, this may cause the organisms to become indistinct (Soave, 1996). The size and sporulation condition of the oocysts in fresh excrement can be used to differentiate between *Cyclospora* and *Cryptosporidium* species. In fresh specimen, *Cryptosporidium* spp. are sporulated and 4–6µm in diameter, but *Cyclospora* spp. are not sporulated and 8–10µm in diameter (Khanna et al., 2014).

However, it is difficult to differentiate *Cyclospora* species from *Eimeria* species based on morphology through microscopic analysis (Sulaiman et al., 2014). Through the use of a nested PCR technique which amplifies a 294 bp fragment of the 18S rRNA gene, *Cyclospora* has been molecularly detected from environmental samples, clinical specimens as well as food products (Jinneman et al., 1998).

Molecular methods offer valuable information for diagnosing *Cyclospora*, especially when it comes to addressing issues with misdiagnosis between *Cryptosporidium* spp. and *C. cayetanensis*. An analysis of nested PCR with particular primers for amplification revealed a 62% sensitivity and a 100% specificity. Nevertheless, other coccidians' DNA, particularly that of the genus *Eimeria*, has been cross-amplified by PCR primers used for *C. cayetanensis* amplification (Garcia-Lopez et al., 1996). Because it relies on modest sequence variation within the 294 bp amplified region, restriction fragment length polymorphism (RFLP) analysis is helpful in differentiating between *C. cayetanensis* and *Eimeria* spp. (Jinneman et al., 1998; Yadav et al., 2015).

Treatment

Despite the lack of a vaccine to prevent cyclosporiasis at this time (Giangaspero & Gasser, 2019), early identification and treatment can have a beneficial therapeutic outcome. In human cyclosporiasis, chemotherapy, and expectant care are essential, especially for immunocompromised people. Long-lasting diarrhea can occasionally cause malnutrition or dehydration, in rare cases, it can cause severe dehydration and infant death, even though cyclosporiasis case fatalities are uncommon in humans (Bednarska et al., 2015).

Cyclosporiasis treatment comprises supportive care, preserving fluid and electrolyte balance, alleviation of symptoms, and antibiotic medication. Trimethoprim-sulfamethoxazole successfully eliminates the organism (Brown & Rotschafer, 1999). It has been reported that human cyclosporiasis can be cured by twice-daily treatment with 160 mg of trimethoprim and 800 mg of sulfamethoxazole (TMP-SMX, also known as co-trimoxazole) for seven days (Escobedo et al., 2009). TMP-SMX is regarded as an effective medication, with numerous trials indicating minimal recurrence rates (Goldberg & Bishara, 2012). Some patients develop allergies and intolerances to TMP-SMX. In such circumstances, ciprofloxacin antibiotic with lower efficacy than TMP-SMX is an affordable treatment approach for human cyclosporiasis (Verdier et al., 2000). Nitazoxanide, an alternate medication, can be applied when ciprofloxacin resistance and sulfur intolerance occur (Li et al., 2020b).

Control

The epidemiological aspects of human cyclosporiasis are poorly recognized in developing Countries; to undertake suitable control and preventive measures, it emphasizes the necessity of studying risk factors and the infection's route of transmission (Yadav et al., 2015).

Since feces-contaminated food, water, and soil are the primary means of transmission for *C. cayetanensis*, enhancing personal hygiene and sanitary conditions can be an effective way to prevent infections with the parasite to eradicate the possibility of fecal-oral transmission in endemic regions through contaminated food, water, and other environmental samples. Avoiding raw fresh produce especially that which comes from endemic areas, will help prevent the cyclosporiasis problem. The infection can also be avoided by routinely boiling and filtering the water used for drinking, food preparation, and cleaning fresh produce (Almeria et al., 2019).

Studies have employed that sodium dichloro iso cyanurate (NaDCC) can be used as a disinfectant against common intestinal protozoa together with *C. cayetanensis* (El Zawawy et al., 2020). Preventing cyclosporiasis also involves reducing the contamination sources in the field, packing houses, and agricultural workers, especially in endemic zones. It is crucial to properly dispose of and treat human sewage. Workers who exhibit any signs of gastroenteritis should not be permitted to handle food or vegetables (Almeria et al., 2019). Magnesium oxide nanoparticle treatment of *C. cayetanensis* oocysts produced observable reductions in sporulation rates in contrast to oocysts that were not treated and could be employed as a safe preventive measure in food and water disinfection procedures (Hussein, et al., 2018).

Conclusion

Cyclosporiasis is a significant food and water-borne intestinal illness, *Cyclospora cayetanensis* is thought to be the only species known to be linked to human infection outbreaks. Various species of *Cyclospora* parasite have been recovered from different animal hosts, although the isolated *Cyclospora* species represent host specificity, and human infection by animal species have not reported. Different animal species play a role in dissimilating of infection in human as a carrier host, so *Cyclospora* spp. Remains as an important diarrheal causing agent in developing countries. Further epidemiological study to obtained more about the biology and transmission routs of *Cyclospora* spp. in different hosts is essential. Fecal contamination of food chains and water supply remains a source for *Cyclospora* infection in human. Elimination of fecal- oral contamination considered as the best approach for controlling human cyclosporiasis via education programs.

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