Giardia duodenalis

Synonymous: *G. intestinalis*, *G. lamblia*
Protozoa
Phylum: Sarcomastigophora

Parasite

anses
French agency for food, environmental and occupational health & safety

Characteristics and sources of *Giardia duodenalis*

Main microbiological characteristics

Giardia duodenalis (synonymous with *G. intestinalis*, formerly *G. lamblia*) is the causative agent of giardiasis. It is a protozoan of the order *Diplomonadida*. It has several genotypes, some of which can parasitise humans. The cycle of *G. duodenalis* includes a highly mobile trophozoite which dies rapidly once outside the host and a stationary ovoid cyst (8 to 16 µm) which is highly resistant in the external environment. The cysts are released intermittently in the stool. They are directly infective and responsible for transmission of the parasite. After ingestion, pepsin in an acidic medium frees the trophozoites after division in the duodenum, where they adhere to enterocytes and then multiply by binary fission. Cysts form under the effect of trypsin and bile salts.

Most human cases of giardiasis are caused by parasites of human origin. Genotypes of *G. duodenalis* recovered from humans (genotypes A and B) are also found among different wild (beavers) or domestic animals (cattle, dogs, etc.). The chronic nature of infection in carrier animals may cause shedding to continue over prolonged periods.

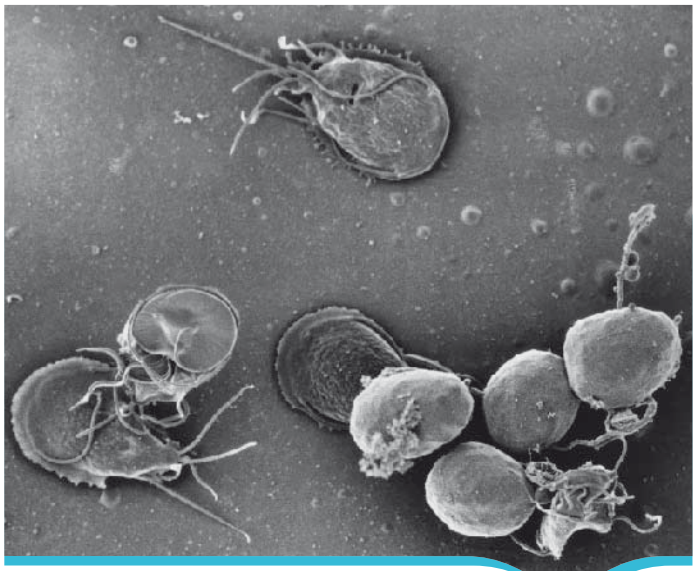
Cysts can survive a considerable length of time in the environment: 15 to 30 days (maximum 74 days) in bovine or human faeces, 28 to 56 days in surface waters depending on temperature conditions (3.5% to 18% of surface water contains viable cysts) and several weeks in wastewater and on agricultural products irrigated with it. Cysts can remain viable for 90 days at 4°C and for 66 days at temperatures between 12 and 22°C.

In tap water, cysts can survive for 77 days at 8°C and for 4 days at 37°C.

Hazard sources

The stools of patients are the main source of the hazard. An individual can shed from 10^8 to 10^{10} cysts per day. After clinical recovery, he may still shed between 10^3 and 10^7 per day for 3 to 4 weeks. Healthy carriers may shed up to 3.10^8 per day.

In production livestock or pets, the vast majority of infections are due to specific genotypes not found in humans, and the role of these animals in the transmission of infection to humans has so far not been clarified.



***Giardia duodenalis* trophozoites (top and lower left) and cysts (lower right) seen through a scanning electron microscope – © CDC/Dr. Stan Erlandsen**

Transmission routes

Direct human-to-human transmission by contact occurs frequently. Cysts are also disseminated through water contaminated by faeces of human or animal origin that are responsible for indirect human-to-human transmission. There is also contamination from wild animals (North American beavers, coypu) and potentially from pets and livestock. Medical staff and paramedics, farmers, veterinarians, and workers in contact with raw sewage are particularly exposed to the hazard, although the zoonotic risk seems minor. Dissemination by insects is possible but unproven.

The main vector of contamination is water (drinking water, water accidentally ingested during bathing or water used for spray irrigation of vegetable crops). The contribution of exposure from the environment is unknown.

Travel in countries with poor hygiene levels may be regarded as a risk factor for contracting giardiasis.

Data sheet on foodborne biological hazards
January 2011

Recommendations for primary production

- Observe good hygiene practices during processing of raw materials (wear gloves), use water intended for human consumption during the process.
- Particular attention should be paid to (i) the cultivation of plants irrigated by sprinklers in case of contamination of irrigation water and (ii) shellfish in case of contamination of shellfish-growing areas by effluent from farms or sewage treatment plants. The *G. duodenalis* hazard should therefore be taken into account when drawing up vulnerability profiles of shellfish-growing areas and particular attention should be paid to preventing contamination of this water.

Human disease

Nature of the disease (Table 1)

Susceptible population group(s)[1]: people with an immunoglobulin A deficiency or gastric hypochlorhydria or malnutrition.

Dose-effect relationship [2]

Ten to 100 cysts can cause symptomatic parasitosis. However, depending on the virulence of the strains, either 100% of symptomatic infections or no infection at all may be observed after ingestion of 50,000 cysts.

Epidemiology

Surveillance system

In France, only clustered cases of waterborne and foodborne outbreaks are subject to mandatory notification. Data compiled by the ANOFEL *Cryptosporidium* network (consisting of 38 hospital laboratories) are highly fragmented because this parasitosis is usually diagnosed by non-hospital clinical laboratories.

In Europe, the European Centre for Disease Prevention and Control (ECDC) centralises the epidemiological data for giardiasis from 30 European countries.

Prevalence

It is a parasitic disease of worldwide distribution, endemic and sometimes epidemic. *G. duodenalis* infects approximately 2% of adults and between 6 and 8% of children in developed countries and is responsible, in a minority of cases, for clinical giardiasis. Prevalence of between 20 and 60% has been reported in developing countries, mainly in children.

In France in 2009, 442 cases among 26,030 patients examined were reported to the ANOFEL *Cryptosporidium* network, i.e. 1.7% of parasitic coprology tests performed in hospitals. This prevalence therefore seems underestimated. In Europe, the prevalence data collected by the ECDC is still probably underestimated and the rate of reporting varies widely between Member States. For 2007, this rate was equal to 5.4 cases per 100,000 inhabitants (excluding Romania). In North America, giardiosis is one of the most common causes of nonbacterial and nonviral diarrhoea.

Epidemics

95 outbreaks of giardiasis have been reported in the last 25 years in the USA. Outbreaks have also occurred in Canada, Australia, New Zealand and in Europe (UK, Norway, Sweden) due to water contamination. Outbreaks have been reported in infant day-care centres. The main risk factors identified during case-control studies on sporadic infections were freshwater bathing, consumption of untreated surface water, contact with children in nappies and consumption of shellfish.

Role of food

Main foods to consider

The food primarily involved in the transmission of giardiasis is water. A lesser contribution is made by foods of animal or plant origin contaminated by water (from irrigation, for instance) and by shellfish grown in areas contaminated by effluent from farms or sewage treatment plants. The majority of non-waterborne outbreaks have been caused by handling of food by infected people or people in contact with patients.

No outbreaks of foodborne giardiasis have been attributed to the consumption of industrially prepared foods.

Retention and inactivation treatments in industrial environments

Retention treatments

Flocculation, sedimentation or membrane filtration treatments are the most reliable. Ultrafiltration or microfiltration can obtain 5 $\log_{10}$ reductions in the initial load. A slow biological filtration results in 4 $\log_{10}$ reductions.

(1) Susceptible population group: people with a higher than average probability of developing symptoms of the disease, or severe forms of the disease, after exposure to a foodborne hazard [definition used for the ANSES data sheets].

(2) The relationship between the dose (the amount of microbial cells ingested during a meal) and the effect on an individual.

Table 1. **Characteristics of the disease**

Mean incubation period	Target population	Main symptoms	Duration of symptoms	Duration of infectious period (shedding)	Complications	Asymptomatic forms
9 to 15 days	Sex ratio M/F: 55/45 Target population: children under 5 years; people caring for children in nappies; travellers in countries with poor hygiene levels; people drinking untreated water or bathing in natural water	In adults: • pasty or sometimes diarrhoeal stools • abdominal pain • anorexia/weight loss In children: • frequent, abundant, oily diarrhoea, 70-92% • anorexia, 40-73% • protein malnutrition, stunted growth and development in cases of chronic infection	From 8 days to 2-18 months. Disappears without treatment in 8 days on average in developed countries.	Several months	Persistent forms (> 6 months): 60% of cases in immuno-compromised subjects	Yes; 85% in children, % unknown in adults

Chemical treatments

There are no current data on resistance to the various methods used to preserve foods other than water (Table 2).

Table 2. **Efficacy of chemical treatment of water**

Treatment processes	CT* values ($mg.L^{-1}.min$) normally used in water treatment in France	CT* values ($mg.L^{-1}.min$) for a reduction (according to pH 6 to 9) of:			
		1 log_{10}		3 log_{10}	
		10°C	20°C	10°C	20°C
Ozone (O_3)	1.6	0.48	0.24	1.4	0.7
ClO_2	12	7.7	5	23	15
Cl_2	15	24-97	12-49	73-292	36-146

* CT: product of the concentration of the disinfectant multiplied by the contact time. It varies depending on water quality (variable organic load).

Physical treatments

Temperature: complete inactivation is achieved at temperatures >55°C or by freezing at -4°C for one week.

Ultraviolet radiation: irradiation at a dose of 400 J/m^2 achieves 3 log_{10} reductions in the initial load of cysts under controlled conditions of implementation.

Monitoring in food

In Europe, there are no regulations governing the detection of *G. duodenalis* in food matrices.

Screening in water: three methods, No. 1623 from the US EPA (2005), ISO 15553 and the French NF T90-455, describe procedures for the enumeration of cysts whose structures appear intact, but provide no information on viability, infectivity or species of the parasites.

Detection of *G. duodenalis* cysts in water is also possible using the PCR method.

Screening in other foods: screening for cysts is possible by PCR after extraction of the parasites by immunomagnetic separation. It is not common practice due to the low detection yield.

Recommendations to operators

- ***G. duodenalis*** **should be taken into account in hazard analyses by operators using foods that are immersed in or spray-irrigated by potentially contaminated water. Appropriate control measures should be taken.**
- **Kitchen staff or anyone else involved in handling foods, especially those intended to be eaten raw or partly cooked, should be made aware of the risk of faecal-oral transmission and the need to observe strict hygiene measures (washing hands thoroughly).**

Domestic hygiene

Recommendations to consumers

- **Observe hygiene rules including thorough washing of hands (after using the toilet, after changing nappies, after contact with animals, etc.), cooking utensils and work surfaces, especially before handling food.**
- **Thoroughly wash foods that may be contaminated with cysts of *G. duodenalis*: lettuce, radishes, carrots, strawberries, etc. Cook food if it cannot be washed normally due to lack of drinking water.**
- **Other important recommendations, particularly for immunocompromised people and young children, as well as in countries with poor hygiene levels: eat only cooked or peeled fruit and vegetables, avoid drinking water that may be contaminated or boil it if necessary before drinking, do not drink untreated surface water or water from wells or sources that have not been analysed, avoid consumption of raw shellfish if not taken from an authorised or inspected growing area.**

Moreover, it should be remembered that swimming in natural waters (lakes, rivers) or artificial bathing pools (AFSSET report, 2009) may represent a risk (by ingestion of water, especially in children).

References and links

Generals references

- Annual Report of the ECDC: http://www.ecdc.europa.eu/en/publications/Publications/0910_SUR_Annual_Epidemiological_Report_on_Communicable_Diseases_in_Europe.pdf#page=102
- Hunter PR, Thompson RC (2005). The zoonotic transmission of *Giardia* and *Cryptosporidium*. Int J Parasitol 35, 1181-90.
- Katz DE, Heisey-Grove D, Beach M, Dicker RC, Matyas BT (2006). Prolonged outbreak of giardiasis with two modes of transmission. Epidemiol Infect 134, 935-41.
- Technical Document for Public Comment Enteric Protozoa: *Giardia* and *Cryptosporidium* Health Canada, 2010. http://clf2-nsi2.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/consult/_2010/giardia-cryptosporidium/giardia-cryptosporidium-eng.pdf
- Yoder JS, Harral C, Beach MJ Giardiasis surveillance - United States, 2006-2008. MMWR Surveill Summ 59, 15-25.

Useful links

- www.VH.org/patients/IBH/intmed/infectious.giardiasis.html
- www.emedicine.com/med/topic868.htm
- www.alapubhealth.org/epi/giardia.htm
- National Reference Laboratory for foodborne parasites: ANSES – Maisons-Alfort laboratory for animal health, 23 avenue du général de Gaulle 94706 Maisons-Alfort cedex.
- ANOFEL *Cryptosporidium* laboratory network (coordinator: francis.derouin@sls.aphp.fr)