Cryptosporidium in water and food

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Cryptosporidium, a protozoan parasite, is a leading cause of diarrhoea and a major cause of child mortality worldwide. The species *C. hominis* and *C. parvum* are responsible for nearly a million deaths every year. *Cryptosporidium* and cryptosporidiosis in different countries differs only in detail from that reported in other regions of the globe. The occurrence and distribution of *Cryptosporidium* species among human and animal hosts is similar to that described elsewhere including the appearance of unique variants. Conditions contributing to observed prevalence mirror those described elsewhere, highest where the human and animal populations have greatest contact and where sanitation is poor. Also, highest among compromised populations including children under five as well as both immune deficient and suppressed populations.

Cryptosporidium oocysts have been detected in surface waters and waste water, in agricultural and livestock waste throughout the different countries of the world. The commonness of fecal wastes from human and non-human hosts suggests that many environments, particularly water and soil, act as vehicles for the spreading of the disease. Some studies have also confirmed oocysts presence in samples of different vegetables e.g., water spinach and in water used for splashing vegetable.

In the field of Drinking Water, Waste Water Treatment, Agriculture and Food, *Cryptosporidium* pathogen has become a dangerous pathogen. *Cryptosporidium* is one of the most important parasitic protozoa of concern to food production worldwide. Methods in current use for *Cryptosporidium* oocysts in drinking water, waste water treatment, food material, mainly vegetables, are never taken in consideration in the countries which are mainly affected with water-, foodborne diseases like cryptosporidiosis. To enhance *Cryptosporidium* surveillance in drinking and waste water chain, techniques are needed to improve our current understanding of the significance of *Cryptosporidium* in primary drinking and waste water production. The conclusions and recommendations based on the data of the proposed study may be applied by health authorities to set guideline for the protection of natural water sources and food crops from pathogens originating from animals, which results in improving their microbial quality, and prevention of transmission of parasites with zoonotic potential to humans.

Methods in current use for *Cryptosporidium* oocysts in water and food materials, are highlighted though attention is given to all available methods. The objective of generating more consistent and reliable data should lead to better understanding of the occurrence, transport, and fate of the oocysts in water and food material. Improvements in monitoring and development for effective methodologies and food/water security offer more practical monitoring possibilities for both the developed and developing worlds.

Water: *Cryptosporidium* has been found in raw and treated waters worldwide. The oocysts evade the filter barriers in the absence of treatment deficiencies and contaminate drinking water. The parasite's density in any kind of water varies, depending on animal activities, agricultural practices, sewage effluences and technologies applied. Evaluation of water treatment technologies is useful for water industries to estimate the real removal and disinfection possibilities of *Cryptosporidium* by any water treatment (filtration and/or disinfection). The multi-barrier concept was found to be the most effective water treatment concept. Backwash water could be highly contaminated and its recycling can increase water contamination of the water source.

Food: *Cryptosporidium* is a food-borne and waterborne intestinal parasite, which pose a threat to human health not only in poor hygiene countries but also in the industrialized and developed world, where the criteria for fresh food preparation are of high standards. These criteria cause problems for the food chain industries, and where few numbers of oocysts are present it is not possible to guarantee that food service offer uncontaminated food to their customers. Standard detection methods don't exist in reality and they require skilled personnel to secure the analysis and the detection of the oocysts in the target food material. Most of the methods described here have been adapted from those used in the water analysis and include both conventional and molecular-based detection. The FDA Bacteriological Analytical Manual (BAM) provides a protocol, designed to detect *Cryptosporidium* oocysts in fresh produce washes and in filterable samples such as juices. To enhance *Cryptosporidium* surveillance in food chain, techniques are needed to improve our current understanding of the

significance of *Cryptosporidium* in primary food production and throughout the various food chains. These include sectors and food industries in which fresh fruit or vegetables appear in ready-to-eat products that are not further heat-processed and not cooked by the consumers.

Swimming pools: Millions of tourists around the Mediterranean countries accept every year all-inclusive holidays. Hotel businesses are not only obligated to offer safe food and water but they will be also affected to compensate claims in the case of infectious and/or outbreaks. Tourist claims management companies are exploiting legal loopholes and touting for business at tourist hotspots like beaches and resorts. However, swimming pools contamination is not excluded and disinfection procedures often are deficient. Due to a lack of qualification and background in the field and a lack of knowledge, there is a lot of demand in education and training of governmental authorities and experts in the field, while reporting lessons learned from outbreaks will provide better insight into the public health impact of waterborne and foodborne *Cryptosporidium* outbreaks. It would be important to coordinate all surveillance systems in between all countries for early detection systems and measures against waterborne-*Cryptosporidium* outbreaks and to establish effective and suitable diagnosis tools according to the country's economic strength and particular needs. The understanding of *Cryptosporidium* epidemiology in Europe and Mediterranean countries create and open new field for research and technologies applications for mitigating the burden associated with cryptosporidiosis. The Euro-Mediterranean region is currently facing not only political, economic and social-demographic challenges that makes environmental and resources protection a topic priority issue.

Further research must be done as an integrated system of ecological, epidemiological, technological and methodological expertise related to the water sources protection. Any countries activities related to increasing water security consistent with Managing Environmental Development aspects of the National Development Strategies are focused on moving toward Integrated Water Resource Management (IWRM) implementation. This process has many public health and environmental implications that require careful evaluation and planning to assure effective and efficient realization of water security goals while recognizing associated health risks and their effective management. The various sources used in producing final product (water and/or food) have pathogen composition definable by appropriate monitoring of source water. Implementation of IWRM may include surface water, brackish groundwater, and wastewater reclaimed from industrial, municipal, and agricultural sources. Each source requires definition of potential pathogen content and implication for final product content based on details of the IWRM scheme. Monitoring to provide baseline information on microbial quality provides the basis for evaluation of alternative schemes and design of operational monitoring to evaluate performance and control effectiveness to minimize risk. Consistent and reliable data should lead to better understanding of the occurrence, transport, and fate of the pathogenic organisms, e.g. Cryptosporidium, in water, their epidemiological and clinical relevance for humans and animals as waterborne pathogens. Clearly, strategies for affecting public health must be adapted to individual regions and their controlling conditions including local environment, available resources, economic and sanitation status. In planning and implementation of monitoring, conventional and new molecular assays suitable for the analysis of water and the detection of the pathogens should be included in order to achieve effective management and minimize health risks effects for water and food.

Although water treatment technologies are effective to remove *Cryptosporidium*, the results in the past show that *Cryptosporidium* evade the filter barriers in the absence of visible treatment deficiencies and low turbidity level and contaminated the final water. This paper will present new and/or adapted suitable existing methodologies addressing challenges on: a) drinking water purification with a focus on *Cryptosporidium* and how *Cryptosporidium* can overcome filter barriers and treatment methodologies; b) waste water treatment, with scope of detection of *Cryptosporidium* and recovery, reuse, recycle; c) outbreaks via water and food; d) evolution and monitoring methodology for *Cryptosporidium* in food material; e) real time monitoring and control systems in food, water distribution and treatment systems; f) Implementation of Integrated Water Resource Management (IWRM).