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FOOD PATHOGEN OF CHICKEN MEAT *Campylobacter* spp.: A REVIEW

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Abstract

C. jejuni and C. coli have the greatest zoonotic potential. In humans, they cause campylobacteriosis with symptoms of food poisoning. Epidemics are mostly related to the consumption of non-chlorinated water and contaminated chicken food and in the spring-summer season. Since 2005, according to the European Food Safety Agency and the European Center for Disease Prevention and Control, campylobacteriosis has been considered the leading alimentary intoxication. A review of the literature was published in Medline, PubMed, Google Scholar, electronically available scientific journals, books, textbooks, proceedings books and reports EFSA/ ECDC, FAO/ WHO. Only literature in English, Bosnian/Croatian/Serbian is included. As a measure to prevent campylobacteriosis, sanitation is recommended in the primary production of chicken meat, and the use of probiotics in meat as biological preservatives is being investigated.

Key words*: Campylobacter spp., chicken meat, epidemiology, sanitation systems, probiotic bacteria.*

INTRODUCTION

Campylobacter spp. are microaerophilic, gram-negative bacteria, of zoonotic potential that cause campylobacteriosis. The most common causes of the disease are: *C. jejuni* (95%) and *C. coli* (2-5%) (Wieczorek and Osek, 2013). Campylobacteriosis is a seasonal zoonosis with a site of action of bacteria on the epithelium of the intestinal and reproductive tract (Chukwu et al., 2019). There is no relevant scientific evidence that humans can be carriers, while warm-blooded animals are considered reservoirs of infection, especially poultry. Thermophilic *Campylobacter* spp. (*C. jejuni* and *C. coli*) are found in the digestive tract of seemingly healthy poultry, often with a percentage of 100%, and are also found on feathers and are a source of infection for humans. Cross-contamination with raw chicken meat is a high risk factor for getting campylobacteriosis. Food should be handled with care to prevent possible food poisoning, the symptoms of which range from mild symptoms (gastroenterocolitis) to possible death. Contamination of raw chicken meat largely depends on slaughter processing. Hazards represent different stages of primary production (fattening, slaughter and primary processing of chicken meat), so it is important to respect hygienic and sanitary standards in different stages of primary production, "*farm to table*" (Crim et al., 2014). It is extremely important to respect the concepts *Hazard Analysis Critical Control Point* (HACCP) which is enabled by the application of *Good Manufacturing Practice* (GMP) and *Good Hygienic Practice* (GHP) (da Cruz, Cenci and Maia, 2006). Each country should have a strategic plan and strict biosecurity measures to prevent contamination of production facilities with thermophilic *Campylobacter* spp. which is the obligation of the Member States of the EU (Bilska and Kowalski, 2014; Facciolà et al., 2017).

General characteristics of *Campylobacter* spp.

Campylobacter spp. belong to the genus *Campylobacter*. Thermophilic species are important for public health: *C. jejuni*, *C. coli*, *C. fetus*, *C. lari*, *C. hyointestinalis* and *C. sputorum* (On, 2001). Thermophilic species are found in the intestines of various animals.

The most important reservoirs of infection are: poultry, domestic and wild animals, pets, birds, mollusks (Brown et al., 2004; Workman et al., 2005). They show high sensitivity to disinfectants, acids and salts. Inactivation is achieved at -12°C, some species survive at -70°C. They show sensitivity to high temperatures and gradual drying (Ivanović, 2004). The optimum temperature is 30°C-45.5°C (Chukwu et al., 2019). These are microaerophilic, gram-negative bacilli, seagull wing shapes or the letter S. They are asporogenic and motile. Most oxidases and catalases are positive, reduce nitrate to nitrite and do not break down glucose. In the differentiation of thermophilic species *C. jejuni* and *C. coli*, hydrolysis of hippurate, which is negative in *C. coli*, is performed and tested. To differentiate *C. lari*, a test is performed on nalidic acid to which isolated *C. lari* is naturally resistant (Markey et al., 2013). Colonies are not subject to hemolysis. They have a variable appearance depending on the *Campylobacter* species and the nutrient media used for cultivation. On Karmala agar they are flat, gray in color, moist and spill, while on Skirrow agar they are gray and brown. On modified agar with *carbon-cefoperazone-deoxycholate* (mCCDA) they are small and flat, gray-white in color, with a tendency to spill and are watery. *C. jejuni* form flat, gray, and water colonies, and *C. coli*, round, glossy, and white (Quinn et al., 2011).

Etiology, epizootiology and epidemiology

Just a drop of chicken juice with *C. jejuni* is enough to cause gastroenterocolitis in the consumer (Tambur et al., 2009). *C. upsaliensis* from pets is also characterized by a low infectious dose, and susceptible are young animals that live in conditions of poor zoohygiene and deficient nutrition (Mohammed, 2010; Marks et al., 2011). Reproductive disorders in cattle and sheep are associated with *C. fetus*. It is rarely isolated from meat due to the lack of appropriate selective media (Wagenaar et al., 2014). The sources of infection for humans are quite wide, because they are ubiquitous bacteria (Wieczorek and Osek, 2013). Transmission is direct through animals and indirect through water and food (Marriott and Gravani, 2006; Tambur et al., 2009; Wieczorek and Osek, 2013). The food most often associated with campylobacteriosis epidemics in different European countries is chicken meat, unpasteurized eggs, unpasteurized dairy products, then non-chlorinated water (Jiménez et al., 2005; Forbes et al., 2009; Silva et al., 2011; Markey et al., 2013). Human-to-human transmission is also possible in immunocompromised humans (Huang et al., 2005). Complications can also occur if bacteria enter the bloodstream through the intestinal wall (Chukwu et al., 2019). Young children and people with HIV, autoimmune and neoplastic diseases are very susceptible to campylobacteriosis (Balen-Topić et al., 2007; Kalenić et al., 2013; Markey et al., 2013).

Epidemiological data

Campylobacteriosis occurs in the spring-summer season (Chukwu et al., 2019). A growth trend has been observed in developed and developing countries (Sahin et al., 2012; Kaakoush et al., 2015). According to the *European Food Safety Authority* (EFSA) and the *European Center for Disease Prevention and Control* (ECDC), the growth trend in the number of patients in Europe has been growing since 2005 and continues to grow (EFSA and ECDC, 2008-2019). In Africa, Asia, Middle East, they are not recorded as leading enterites (Vukelić et al., 2003). In underdeveloped countries, one billion people get intestinal infections annually (Trošelj-Vukić and Cekinović, 2010).

Pathogenesis and pathogenicity

Bacteria possess the ability to adhere, to adhere to the substrate. They are characterized by mobility that has a directed movement (chemotaxis) towards various organs through the epithelium (translocation). They can invade the epithelium (invasion), form a biofilm, release endotoxins and resist immunity (Quin et al., 2011; Bolton, 2015; Kaakoush et al., 2015).

Immune and non-immune defense mechanisms

Host immunity is based on cellular, humoral immunity and non-immune defense mechanisms (Begovac et al., 2006). Cellular immunity in the form of T lymphocyte

production is important in immunocompromised patients, in patients with autoimmune diseases, HIV infection, neoplastic diseases. In campylobacteriosis, the humoral immune response is more significant where IgA immunoglobulins (acute phase), IgG, IgM play a major role. Overcoming the infection leaves an insecure immunity (Vučković and Abram, 2009; Markey et al., 2013). The non-immune response depends on the composition of the intestinal flora. Bacteria of the genus *Lactobacillus* and *Bifidobacterium* play a significant role in alleviating the clinical picture, because they release bactericidal, fungicidal, virucidal substances (Ljungh and Wadstrom, 2006; Zhang et al., 2017). Probiotics reduce the possibility of complications of campylobacteriosis in the form of celiac disease, Crohn's disease, ulcerative colitis, etc. (Lebwohl et al., 2015).

Probiotics in food (biological preservatives)

Foods enriched with probiotic cultures of the genera *Lactobacillus* and *Bifidobacterium* contributes to health (FAO and WHO, 2001). For the fermentation of dairy products, one of the most well-known species is *Lactobacillus acidophilus* (Ljungh and Wadstrom, 2006; Fijan, 2014). *Lactobacillus* convert sugars into lactic acid and serve in the preparation of fermented products (Fabre-Gea et al., 2000). *Lactobacillus* have the ability to synthesize bacteriocins that damage pathogens. The effect is still being investigated, and nisin is used (Cotter et al., 2013).

Bacteriocins are used today as biological food preservatives, and canning of dairy products is also recommended (Perez, Zendo, & Sonomoto, 2014). *Lactobacillus salivarius* and *Lactobacillus plantarum* can inhibit the growth of *Campylobacter* spp. From food (Messaoudi et al., 2012; Wang et al., 2014).

MATERIALS AND METHODS

It is an analytical review of the literature of index databases *Medline*, *PubMed*, index and citation databases then citation databases *Google Schoolar*, various articles in veterinary medicine, agricultural, public health, biomedical sciences, medical sciences and science about food, electronically available scientific journals, different books, textbooks, proceedings books and reports EFSA/ ECDC and FAO/ WHO. Inclusion criteria: Available literature in English, Bosnian/Croatian/Serbian. Exclusion criteria: Literature in other languages.

RESULTS AND DISCUSSIONS

Campylobacteriosis is caused by animal, pathogenic bacterial species of the genus *Campylobacter*, which in humans most often cause symptoms of acute food poisoning. The most pathogenic species for humans are *C. jejuni*, *C. coli*, *C. upsaliensis*, and *C. lari* (Workman et al., 2005). The most common causes of campylobacteriosis in humans are *Campylobacter jejuni* (95%) and *Campylobacter coli* (2-5%) (Wieczorek and Osek, 2013). The food that is most often associated with reported epidemics of campylobacteriosis is chicken meat, unpasteurized eggs, unpasteurized dairy products, etc. (Silva et al., 2011; Markey et al., 2013). It is a predominantly gastrointestinal infection, but reproductive infections are also possible (Chukwu et al., 2019). It is primarily transmitted through contaminated water and food or by direct contact with animals that transmit the infection. Secondary transmission refers to subsequently contaminated food with animal feces (Nicholas, 2005; Markey et al., 2013). Subsequent contamination of meat most often occurs in primary production, so it is important to respect hygienic and sanitary standards at different stages of primary production (fattening, slaughter, primary processing) (Crim et al., 2014). The application of *Hazard Analysis Critical Control Point* (HACCP), *Longitudinal Integrated Safety Assurance* (LISA), *Good Manufacture Praxis* (GMP), *Quality, Safety, Acceptability* (QSA) and *Specific Patogen Free* (SPF) systems for the purpose of "*safe food*" production is also very important (da Cruz, Cenci and Maia, 2006). Based on epidemiological data, epidemics of campylobacteriosis are most often associated with developed countries: Sweden, Denmark and the United States (Sahin et al., 2012; Kaakoush et al., 2015). The increase in campylobacteriosis is evident in developing countries, and is least present in

underdeveloped countries in Africa, Asia and the Middle East (Vukelic et al., 2003). In Europe, there has been a growing trend of campylobacteriosis since 2005 and it is the leading alimentary intoxication (EFSA and ECDC, 2008). The mechanisms of campylobacter pathogenicity are: adherence, motility, chemotaxis, invasion, translocation, endotoxins, resistance to immunity, and the possibility of biofilm formation (Quin et al., 2011; Bolton, 2015; Kaakoush et al., 2015). Virulence is related to the strength of the released endotoxin (Markey et al., 2013). Immunity resistance is related to the lack of cytokine release.

The clinical picture of the disease is related to cellular and humoral immunity. Cellular immunity refers to the release of T-lymphocytes, the so-called "*Killer cell*", and humoral immunity to the production of antibodies, immunoglobulin IgA, IgG and IgM. In campylobacteriosis, humoral immunity is more important (Vučković and Abram, 2009; Markey et al., 2013). In the fight against campylobacteriosis, there are also non-immune defense mechanisms related to the composition of the intestinal flora of the host. Bacteria of the genera *Lactobacillus* and *Bifidobacterium* play a significant role in alleviating the clinical picture of campylobacteriosis (Ljungh and Wadstrom, 2006). Bacteriocin enzymes, which are the product of probiotic bacteria, can also be used in food preservation as biological preservatives in the so-called. "*New food*", which excludes the use of harmful, chemical compounds nitrite and nitrate, which are necessary for food to be free of pathogens (Perez, Zendo and Sonomoto, 2014).

CONCLUSIONS

A review of the literature revealed that *C. jejuni* and *C. coli* are significant contaminants of broiler chicken meat. Campylobacteriosis is a public health problem. The first measure to control the spread of *Campylobacter* spp. in food there is a laboratory detection of the causative agent. Determining the seasonality and prevalence of thermophilic *Campylobacter* spp. obtained in the primary production of broiler chicken meat, is also important in obtaining epidemiological data that are needed in the development of a strategy to control the spread of campylobacteriosis.

Prevention includes sanitation in primary chicken production, the avoidance of cross-contamination and consideration of the use of probiotics bacteria as biological preservatives.

ABBREVIATIONS

Campylobacter spp.: *Campylobacter species*; ECDC: European Centre for Disease Prevention and Control; EFSA: European Food Safety Authority; GHP: Good Hygiene Practice; GMP: Good Manufacture Practice; HACCP: Hazard Analysis Critical Control Point.

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