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The importance of *Aeromonas hydrophila* in food safety

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Abstract

Aeromonas hydrophila is a widespread representative of *Aeromonas* found in water, water habitants, domestic animals and foods (fish, shellfish, poultry, and raw meat). The microorganism has the potential to be a foodborne pathogen, especially strains from hybridization group (HG1), associated with clinical cases of illness. The pathogen produces different virulence factors including exotoxins, cytotoxins and others. As a psychrotroph, *A. hydrophila* grow in foods during refrigeration. The disease spectrum associated with this microorganism includes gastroenteritis, septicemia, traumatic and aquatic wound infections, and infections after medical leech therapy. Multiple resistance of the bacterium to many antimicrobials is a fact of high significance. The potential of *A. hydrophila* to become a foodborne pathogen is a controversial issue. Many approaches are effective for control of the presence of *A. hydrophila* in food for human consumption.

Keywords: *Aeromonas hydrophila*; Foodborne pathogen; Food safety; Foodborne illness

1. Introduction

Aeromonas hydrophila is an emerging aquatic pathogen, widely distributed in the environment. Originally, *A. hydrophila* was identified as one of four *Aeromonas* species by Popoff (1984). According to Joseph and Carnahan (2000) the genus *Aeromonas* is now classified within the family *Aeromonadaceae* and consists of 14 different confirmed species, one of which is *A. hydrophila*.

Swann and White (1991), Gosling (1996) and Austin and Adams (1996) consider *A. hydrophila* as a cause of several disease conditions in cold-blooded animals (fish, reptiles, amphibians) and in warm-blooded animals (mammals and birds). An important fact, however, is that *A. hydrophila* is the cause of zoonotic diseases (i.e., diseases which can be spread from animals to humans and vice versa).

According to Adams and Moss (2000) and Kirov (2001) *Aeromonas* (principally *A. hydrophila*) currently has the status of a foodborne pathogen of emerging importance. It has attracted attention primarily because of its ability to grow at cold temperatures. *Aeromonas* spp. were first considered as possible causative agents of human gastroenteritis more than 30 years ago (Lautrop, 1961). Palumbo (1996) reported that *A. hydrophila* has been isolated from a wide range of both animal and plant food products, including raw red meat, poultry, fin fish, seafood, dairy products, vegetables and miscellaneous foods. The potential role of *A. hydrophila* in human gastrointestinal infections is noted by Kirov (2003). The majority (>85%) of gastroenteritis cases are attributed to three *Aeromonas* species, one of them is *A. hydrophila* (hybridization group HG1). The aim of this review is to describe the potential association of

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A. hydrophila with foodborne illness, its pathogenic characteristics, the distribution of the pathogen in the environment and foods, and some approaches to control the microorganism in drinking water and food.

2. Characteristics of *A. hydrophila*

Members of the genus *Aeromonas* (from the Greek aer-air/gas monas-unit hence gas-producing unit) are Gram-negative, facultatively anaerobic, non-spore-forming, rod-shaped bacteria (Roberts, Baird-Parker, & Tompkin, 1996). According to Adams and Moss (2000) and Kirov (2003) *A. hydrophila* is motile by a single polar flagellum, catalase-positive, oxidase-positive rod, which ferments glucose. It is neither salt (<5%) nor acid (min. pH ~ 6.0) tolerant and grows optimally at around 28 °C. It has the ability to grow at cold temperatures, reportedly as low as −0.1 °C for some strains. Its principal reservoir is the aquatic environment such as freshwater lakes and streams and wastewater systems. Kirov (2003) reported on its ability to form lateral flagella on solid surfaces.

Current genomospecies (*A. hydrophila*, *A. bestiarum* and one unnamed species) and phenospecies (*A. hydrophila*, and *A. hydrophila*-like) within *A. hydrophila* by Kirov (2003) are grouped in identified by Popoff (1984) three DNA hybridization groups (HG1, isolated from clinical specimens, HG2 and HG3). According to Kirov (2003) pathogenicity and virulence of *A. hydrophila* depend on the ability to produce factors associated with gastroenteritis. These properties are exotoxins, cytotoxins, endotoxins, siderophores, invasins, adhesins, S-layers and flagella. Many authors assayed enterotoxic, cytotoxic, hemolytic activities, adhesion, and invasion of already listed virulence determinants. Jiwa (1983) studied enterotoxigenicity, hemagglutination and cell-surface hydrophobicity in 31 strains of *A. hydrophila*. The origin of *A. hydrophila* was from human stools (diarrhea) 17, hare (septicemia) 7, aquarim fish and tibifex worm (routine) 5, and gold fish/carp (septicemia) 2 strains. Of 31 *A. hydrophila* strains, 28 caused cytotoxic reactions; the 3 cytotoxic-negative strains were from routine fish isolates. Hemagglutination depends on the growth conditions of *A. hydrophila* strains; 23 of 31 strains, grown on, (TY-1) broth showed mannose resistant hemagglutination. Thirty of the 31 *A. hydrophila* strains were hemolytic on horse blood agar. Fricker and Tompsett (1989) reported cytotoxin production by 50% of the *A. hydrophila* strains isolated from retail outlets (mostly poultry and offal). Knochel (1989) examined the production of hemolysin at low (10 °C) and at body temperature (37 °C) of 97 clinical strains of *Aeromonas* spp. (74 strains of *A. hydrophila*) isolated from warm and cold sources. Enterotoxin-like activity of some strains was assessed by the suckling mouse assay. Hemolysin production of 3 from 5 strains of *A. hydrophila*, isolated from source with high temperature (>24 °C) was high (titer >128) at low (10 °C) and at body temperature (37 °C). Significantly higher numbers of *A. hydrophila* (69 strains) isolated from low-temperature sources were able to produce high hemolysin titers at 10 °C (47 strains) as compared with 37 °C (6 strains). After growth at 37 °C, regardless of the hemolytic titer, 40% (4 strains) of *A. hydrophila* were enterotoxic; at the same time 30% (3 strains) after growth at 10 °C were enterotoxigenic. Majeed, Egan, and Mac Rae (1989a) isolated enterotoxigenic aeromonads (*A. hydrophila*, *A. sobria* and *A. caviae* strains) from retail lamb meat and offal. This study showed that exotoxin production (haemolysin and enterotoxin) was more characteristic of *A. hydrophila* and *A. sobria*. Isolates of *A. hydrophila* dominated other *Aeromonas* representatives and they have no parallele between haemolysin and enterotoxin production of strains. Todd, Hardy, Stringer, and Bartholomew (1989) studied four strains of *A. hydrophila* grown at 30 and 37 °C in two laboratory media and prawn puree for toxin production. Results showed reduced cytotoxic and hemolytic activities in prawn puree compared with two media, but in most cases increased proteolytic activity. No enterotoxic activity was observed in prawn puree. Kirov and Brodribb (1993) reported high levels of exotoxin production in different foods of a strain of *A. hydrophila* isolated from goats' milk. Esteve, Amaro, Garay, Santos, and Toranzo (1995) reported that pathogenic strains of *A. hydrophila* from eel produced elastases, hemolysins and exotoxins, inactivated by heat treatment. Handfield, Simard, Coullard, and Letarte (1996) investigated pathogenicity of isolates from food and drinking water by studying its hemolysis, hemagglutination and cytotoxicity. Hemolysis was more frequently seen with water isolates (64%), hemagglutination was more frequently encountered with food isolates (92%), and cytotoxicity was frequently observed with food (92%) and water (73%) isolates. Heat treatment (56 °C for 10 min) inhibited the toxicity of some but not all toxin-producing isolates. Moro et al. (1999) isolated four strains of *A. hydrophila* from four Hereford bulls with seminal vesiculitis in South Brasil. All isolates produced enterotoxins, two cytotoxins, and 1 isolate hemolysin. Castro-Escarpulli et al. (2003) reported two strains of *A. hydrophila* from market tilapia in Mexico with putative virulence factors such as aerolysin/hemolysin, lipases including the glycerophospholipid-cholesterol acyltransferase, serine protease and DNases.

The majority of *A. hydrophila* strains produce exotoxic properties (enterotoxins, hemolysins, and cytotoxins). Adhesion to and colonization of mucosa, followed by fluid accumulation, or epithelial change, are likely events leading to human disease. Sanderson, Ghazali, and Kirov (1996) studied enteropathogenicity of *A. hydrophila* (three human diarrhoeal strains) in mice