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Food borne diseases bacteria; frequency antibiotic resistance bacteria in Iranian foods

Shila Jalalpour

Lecture of Microbiology, Islamic Azad University Shahreza Branch, Membership of Young Researcher Club, Isfahan, Iran. E-mail: shilla.jalalpoor@yahoo.com.

Food borne illnesses result from eating food or drinking beverages that are contaminated with chemicals matter, heavy metals, parasites, fungi, viruses and Bacteria. *Bacillus* species and *Staphylococcus aureus* are one of food borne diseases Bacteria. *Bacillus* species are spore forming bacteria and the spores may be present on raw foods, and their ability to survive high cooking temperatures requires that cooked foods be served hot or cooled rapidly to prevent the growth of this bacteria. *S. aureus* are found on humans (skin, infected cuts, pimples, noses and throats). The subject of this study was study on frequency antibiotic resistance bacteria in Iranian foods. Related papers on importance and frequency of antibiotic resistance bacteria in foods were extracted from original and review articles published in Pubmed and Elsivier Science during the period of 1995 to 2011. For this study key words which were search include "food borne diseases bacteria, *Staphylococcus, Bacillus,* antibiotic resistance and Iran". About the spread of antibiotic resistance bacteria in foods in all of similar original and review articles, there is consensus that the existence of antibiotic resistance strains in foods, finally lead to increase of antibiotic resistance nosocomial in humans. Result of this study indicates high frequency of antibiotic resistant and beta lactamase producer pathogen bacteria in Iranian foods.

Key words: Food borne diseases bacteria, *Staphylococcus, Bacillus,* antibiotic resistance.

INTRODUCTION

Food borne illness is an ever-present threat that can be prevented with proper care and handling of food products. It is estimated that between 24 and 81 million cases of food borne diarrhea disease occur each year in the United States, costing between $5 billion and $17 billion in medical care and lost productivity (Doyle and Erickson, 2007; Jay, 2000; Tribe, 2008).Chemicals, heavy metals, parasites, fungi, viruses and bacteria can cause food borne illness (Center for food safety and applied nutrition, 2007; Marasas et al., 2007; Webley, 2007; World Health Organization, 2007). Bacteria related food poisoning is the most common, but fewer than 20 of the many thousands of different bacteria actually are the culprits. More than 90 percent of the cases of food poisoning each year are caused by *Staphylococcus aureus, Salmonella, Clostridium perfringens, Campylobacter, Listeria monocytogenes, Vibrio*

parahaemolyticus, Bacillus cereus, Entero-pathogenic *Escherichia coli* and *Shigella* spp. These bacteria are commonly found on many raw foods. Normally a large number of food-poisoning bacteria must be present to cause illness. Therefore, illness can be prevented by (1) controlling the initial number of bacteria present, (2) preventing the small number from growing, (3) destroying the bacteria by proper cooking and (4) avoiding re-contamination (Food and Drug Administration, 2007a, b; Joffe et al., 2007; Mazur et al., 2007; Mead, 1999). *Bacillus cereus* has been recognized as an agent of food poisoning since 1955. There are only a few outbreaks a year reported by CDC. Between 1972 and 1986, 52 outbreaks of food-borne disease associated with *B. cereus* were reported to the CDC (in 2003, there were two), but this is thought to represent only 2% of the total cases which have occurred during these periods. It is not

a reportable disease, and usually goes undiagnosed (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996). *B. cereus* causes two types of food-borne illnesses. One type is characterized by nausea and vomiting and abdominal cramps and has an incubation period of 1 to 6 h. It resembles *S. aureus* (staph) food poisoning in its symptoms and incubation period. This is the short incubation or emetic form of the disease (Agata, 1995; Ehling, 2004; Kotiranta, 2000; Todar's, 2009). The second type is manifested primarily by abdominal cramps and diarrhea following an incubation period of 8 to 16 hours. Diarrhea may be a small volume or profuse and watery. This type is referred to as the "long-incubation" or diarrheal form of the disease, and it resembles food poisoning caused by *Clostridium perfringens.* In either type, the illness usually lasts less than 24 h after onset. In a few patients symptoms may last longer (Agata, 1995; Ehling, 2004; Kotiranta, 2000; Todar's, 2009).

The short-incubation form is caused by a preformed, heat-stable emetic toxin, ETE. The mechanism and site of action of this toxin are unknown, although the small molecule forms ion channels and holes in membranes. The long-incubation form of illness is mediated by the heat-labile diarrheagenic enterotoxin Nhe and/or hemolytic enterotoxin HBL, which cause intestinal fluid secretion, probably by several mechanisms, including pore formation and activation of adenylate cyclase enzymes. *Bacillus cereus* produces one emetic toxin (ETE) and three different enterotoxins: HBL, Nhe, and EntK (Ehling et al., 2007; Hoton et al., 2005; Pinna et al., 2001).

Two of the three enterotoxins are involved in food poisoning. They both consist of three different protein subunits that act together. One of these enterotoxins (HBL) is also a hemolysin; the second enterotoxin (Nhe) is not a hemolysin. The third enterotoxin (EntK) is a single component protein that has not been shown to be involved in food poisoning. All three enterotoxins are cytotoxic and cell membrane active toxins that will make holes or channels in membranes (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996). The emetic toxin (ETE) is a ring-shaped structure of three repeats of four amino acids with a molecular weight of 1.2 kDa. It is a K^+ ionophoric channel, highly resistant to pH between 2 and 11, to heat, and to proteolytic cleavage (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip 2000; Todar's, 2009; Turnbull, 1996).

The nonhemolytic enterotoxin (Nhe) is one of the three-component enterotoxins responsible for diarrhea in *Bacillus cereus* food poisoning. Nhe is composed of NheA, NheB and NheC. The three genes encoding the Nhe components constitute an operon. The *nhe* genes have been cloned separately, and expressed in either *Bacillus subtilis* or *Escherichia coli*. Separate expression showed that all three components are required for

biological activity (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996). The hemolytic enterotoxin, HBL, is encoded by the *hbl*CDA operon. The three protein components, L1, L2 and B, constitute a hemolysin. B is for binding; L1 and L2 are lytic components. This toxin also has dermonecrotic and vascular permeability activities, and it causes fluid accumulation in rabbit ileal loops (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996).

B. cereus is a soil dwelling bacteria responsible for 2 to 5% of cases of food poisoning worldwide. All people are susceptible to Bacillus cereus food poisoning, which can occur year-round in any part of the world. *Bacillus cereus* has been recognized as a food poisoning agent since 1955. A variety of foods have been associated with the long-incubation form of *Bacillus cereus* food poisoning. These include meat, vegetables, milk, and fish. Mixtures such as sauces, soups, casseroles, and pastries have also been linked to outbreaks of food poisoning. The short-incubation version of the illness is mainly associated with cooked rice that has been improperly refrigerated, such as the fried rice found in some Chinese restaurants.

Rice that has been cooked and then held at warm temperatures for an extended period of time seems to be a preferred host for this type of bacteria, and it grows quickly in these conditions. Other foods rich in starch, such as pasta and potato products, have also been known to transmit the illness (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996). Sickness can be caused by consuming less than 150 cells of the *Bacillus cereus* bacteria.

The short-incubation food poisoning results in nausea and vomiting 1 to 5 h after consuming the contaminated food. The long-incubation version creates heavy nausea, abdominal pain, and diarrhea 8 to 16 h after ingesting the bacteria. A small volume of diarrhea may be present with the short-incubation version as well. Complications from *Bacillus cereus* food poisoning are rare (Ehling et al., 2007; Hoton et al., 2005; Pinna et al., 2001). Most cases of *Bacillus cereus* food poisoning resolve themselves without medical treatment. Rehydration, either orally or intravenously, may be needed to replace fluids lost through vomiting or diarrhea. Antibiotics are normally not given, as the bacteria have been found to be resistant to penicillin. This illness cannot be spread by person to person contact. The only way to contract the illness is by consuming contaminated food (Davis et al., 2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996). The number of cases of *Bacillus cereus* food poisoning reported annually ranges from 6 to 50 cases. The occurrence of the illness may be much greater as many cases are not reported and do not require medical treatment. Many people who contract this illness just wait for the symptoms to pass and self-treat

themselves at home with rest and fluids. Many reported cases are due to an outbreak of Bacillus cereus food poisoning affecting a number of people, usually because they all ate the same food at the same restaurant (Davis et al.2008; Ehling et al., 2004; Kotiranta et al., 2000; McKillip, 2000; Todar's, 2009; Turnbull, 1996).

Antibiotic resistance is the ability of a micro-organism to withstand the effects of an antibiotic. It is a specific type of drug resistance. Antibiotic resistance evolves naturally via natural selection through random mutation, but it could also be engineered. SOS response of low-fidelity polymerases can also cause mutation via a process known as programmed evolution. Once such a gene is generated, bacteria can then transfer the genetic information in a horizontal fashion (between individuals) by plasmid exchange. If a bacterium carries several resistance genes, it is called multiresistant or, informally, a superbug (Jalalpoor et al., 2007). Beta-lactamases are enzymes (EC 3.5.2.6) produced by some bacteria and are responsible for their resistance to beta-lactam antibiotics like penicillins, cephalosporins (are relatively resistant to beta-lactamase), cephamycins, and carbapenems (ertapenem). These antibiotics have a common element in their molecular structure: a four-atom ring known as a beta-lactam. The lactamase enzyme breaks that ring open, deactivating the molecule's antibacterial properties (Jalalpoor et al., 2007; Jalalpoor et al., 2008a, b). Beta-lactam antibiotics are typically used to treat a broad spectrum of Gram-Positive and Gram-negative bacteria. Beta-lactamases produced by Gram-positive organisms are usually secreted (Jalalpoor et al., 2007; 2008a, b).

Penicillinase is a specific type of β-lactamase, showing specificity for penicillins, again by hydrolysing the beta-lactam ring. Molecular weights of the various penicillinases tend to cluster near 50 kD (Jalalpoor et al., 2007). Penicillinase was the first beta lactamase to be identified: it was first isolated by Abraham and Chain in 1940 from gram-negative E. coli even before penicillin entered clinical use but penicillinase production quickly spread to bacteria that previously did not produce it or only produced it rarely. Penicillinase-resistant beta-lactams such as methicillin were developed, but there is now widespread resistance to even these (Jalalpoor et al., 2007).

S. aureus food poisoning is an illness that results from eating food contaminated with a toxin produced by the S. aureus bacteria (Jay, 2000). S. aureus food poisoning is often caused when a food handler contaminates food products that are served or stored at room- or refrigerator temperature. Common examples of such foods are desserts (especially custards and cream-filled or topped desserts), salads (especially those containing mayonnaise, such as tuna salad, potato salad, and macaroni salad), poultry and other egg products, and casseroles (Cenci et al., 2003; Cimolai 2008; Matthews et al., 1997; Whitt et al., 2002). Staphylococcal food poisoning is caused by eating food contaminated with S. aureus. S. aureus is able to grow in a wide range of temperatures, pH (4.2 to 9.3) and sodium chloride (salt) concentrations. These characteristics enable S. aureus to grow in a wide variety of foods and conditions. Often this type of food poisoning occurs when cooked food is allowed to cool slowly and/or sit at room temperature for some time. The warm food allows the S. aureus bacteria to grow. These bacteria produce a toxin -enterotoxin that remains in the food even when reheated. The symptoms are caused by the toxin not by the bacteria themselves, hence staphylococcal food poisoning is sometimes called food intoxication' (Liu, 2005; Liu et al., 2008; Patel et al., 1987; Schneewind et al., 1995; Zhu et al., 2008). Staphylococci are ubiquitous. These bacteria are present in air, dust, dirt, sewage, water, milk, and food, or on food equipment, environmental surfaces, humans, and animals. Humans and animals are the primary reservoirs. Staphylococci are present in the nasal passages and throats and on the hair and skin of 50% or more of healthy individuals. The colonization rate is even higher for those who work with or who come in contact with sick individuals and hospital environments (Cenci et al., 2003; Cimolai 2008; Matthews et al., 1997; Whitt et al., 2002; Schneewind et al., 1995).

The bacteria produce a toxin in the food, which causes most of the symptoms. Risk factors include: Eating food that was prepared by a person with a skin infection (these infections commonly contain S. aureus bacteria), Eating food kept at room temperature, Eating improperly prepared food, Eating the same food as someone who has symptoms, Symptoms usually appear within 1- 6 h after eating contaminated food. Usually, symptoms last only 2 days or less, They may include: nausea, vomiting for up to 24 h, diarrhea, loss of appetite, severe abdominal cramps, abdominal distention, Mild fever (Liu, 2005; Liu et al., 2008; Patel et al., 1987; Schneewind et al., 1995; Zhu et al., 2008). The goal of treatment is to replace fluids and electrolytes (salt and minerals) lost by vomiting or diarrhea. Antidiarrheal medications may be used, but are often not needed. Full recovery is expected. Recovery usually occurs in 24 to 48 h (Liu, 2005; Liu et al., 2008; Patel et al., 1987; Schneewind et al., 1995; Zhu et al., 2008). To avoid dehydration, you or your child should drink water and electrolyte solutions to replace fluids lost by vomiting. A variety of pleasant-tasting electrolyte solutions are available over-the-counter. Solutions to try for children: Pedialyte and Infalyte, Popsicles or Jello (Liu, 2005; Liu et al., 2008; Patel et al., 1987; Schneewind et al., 1995; Zhu et al., 2008). People with diarrhea who are unable to take fluids by mouth because of nausea or vomiting may need intravenous fluids. This is true especially for small children, People taking diuretics ("water pills") may need to stop taking them during the acute episode. Ask your health care provider for instructions (Liu, 2005; Liu et al., 2008; Patel et al.,1987; Schneewind et al., 1995; Zhu et al., 2008).

The subject of this study was survey prevalence Beta lactam resistance in *Bacillus* and *Staphylococcus* species isolated from Iranian foods.

MATERIALS AND METHODS

For present study related papers on importance and frequency of antibiotic resistance bacteria in foods were extracted from original and review articles published in Pubmed and Elsivier Science during the period of 1995 to 2011. For this study key words which were search include food borne diseases bacteria, *Staphylococcus, Bacillus,* Antibiotic Resistance and Iranian Foods".

RESULTS AND DISCUSSION

According results of previous study in Iran100% food sample was contaminated with *Bacillus* species and according to acidometric result frequency of β-lactamase was 65%. According results of another previous study in Iran 95% food sample was contaminated with *Staphylococcus* species and according to acidometric result frequency β-lactamase in the *Staphylococcus* species was 75% (Jalalpoor, 2011a,b).

The first step in preventing food poisoning is to assume that all foods may cause food-borne illness. Follow these steps to prevent food poisoning: Wash hands, food preparation surfaces and utensils thoroughly before and after handling raw foods to prevent recontamination of cooked foods; Keep refrigerated foods below 40 degrees F; Serve hot foods immediately or keep them heated above 140 degrees F; Divide large volumes of food into small portions for rapid cooling in the refrigerator. Hot, bulky foods in the refrigerator can raise the temperature of foods already cooled. Remember the danger zone is between 40 degrees F and 140 degrees F;

Follow approved home-canning procedures. These can be obtained from the Extension Service or from USDA bulletins; Heat canned foods thoroughly before tasting; When in doubt, throw it out (Food and Drug Administration, 2008; Jay 2000). Infants, older persons, women who are pregnant and anyone with a com-promised immune system are especially susceptible to food-borne illness. These people should never consume raw fish, raw seafood, or raw meat type products (Food and Drug Administration, 2008; Jay 2000).

Conclusion

Antibiotic resistance can also be introduced artificially into a micro-organism through transformation protocols. This can be a useful way of implanting artificial genes into the micro-organism (Jalalpoor et al., 2007). Antibiotic resistance is a consequence of evolution via natural selection or programmed evolution. The antibiotic action is an environmental pressure; those bacteria which have a mutation allowing them to survive will live on to reproduce. They will then pass this trait to their offspring, which will be a fully resistant generation (Jalalpoor et al., 2007). The onset of symptoms in staphylococcal food poisoning is usually rapid and in many cases severe, depending on individual susceptibility to the toxin, the amount of contaminated food eaten, the amount of toxin in the food ingested, and the general health of the victim (Food and Drug Administration, 2007; Mead, 1999). It is important to prevent the contamination of food with *Staphylococcus* before the toxin can be produced. *S. aureus* is often present on skin, under fingernails, in the nose and throat, in cuts, abrasions, boils, and abscesses. *S. aureus* can also be found on contaminated surfaces and food preparation utensils. The following can help prevent staphylococcal food poisoning:

Washing hands and under fingernails vigorously with soap and water before handling and preparing food; Not preparing food if a person has a nose or eye infection; Not preparing or serving food for others if a person has wounds or skin infections on the hands or wrists; Keeping kitchens and food-serving areas clean and sanitized; Keeping hot foods hot (over 140°F) and cold foods cold (40°F or under); Especially if the food is stored for more than 2 h; Storing cooked food in a wide, shallow container and refrigerating as soon as possible (Food and Drug Administration, 2007; Mead, 1999). Antibiotic resistance can also be introduced artificially into a micro-organism through transformation protocols. This can be a useful way of implanting artificial genes into the micro-organism (Jalalpoor et al., 2007). Several studies have demonstrated that patterns of antibiotic usage greatly affect the number of resistant organisms which develop. Overuse of broad-spectrum antibiotics, such as second- and third-generation cephalosporins, greatly hastens the development of methicillin resistance, even in organisms that have never been exposed to the selective pressure of methicillin *per se* (thus the resistance was already present). Other factors contributing towards resistance include incorrect diagnosis, unnecessary prescriptions, improper use of antibiotics by patients, and the use of antibiotics as livestock food additives for growth pro-motion (Jalalpoor et al., 2007). Staphylococcal resistance to penicillin is mediated by penicillinase (a form of β-lactamase) production: an enzyme that cleaves the β-lactam ring of the penicillin molecule, rendering the antibiotic ineffective. Penicillinase-resistant β-lactam antibiotics such as methicillin, nafcillin, oxacillin, cloxacillin, dicloxacillin, and flucloxacillin are able to resist degradation by staphylococcal penicillinase (Jalalpoor et al., 2007). Spread of *S. aureus* (including MRSA) is through human-to-human contact, although recently some veterinarians have discovered that the infection can be spread through pets, with environmental contamination thought to play a relatively unimportant part. Emphasis on basic hand washing techniques are therefore, effective in preventing the transmission of *S. aureus* (Jalalpoor et

al., 2007).

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