



## Gram-Negative Food Borne Pathogen: A Review

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### Introduction

The term "food-borne diseases" refers to illnesses contracted by ingesting contaminated food and includes both foodborne infections and foodborne intoxications. It is also frequently used interchangeably with "food poisoning." Approximately 3-5 billion episodes of diarrhea and over 1.8 million deaths in children under the age of five are estimated to occur globally, according to the WHO. A sizable portion of these incidents are attributed to consuming food, primarily food of animal origin contaminated with microbial pathogens or toxins.

**Foodborne Diseases** - Food borne diseases may be caused by bacteria and bacterial toxins, viruses, fungi and fungal toxins, zoonotic parasites/protozoans, pesticide residues, drug residues, heavy metals, food adulterants and food additives. Among these, microbiological contaminants are most important in the context of developing countries. To date, 250 different foodborne diseases have been described and bacteria are the causative agents of 2/3rd of them. Among the predominant bacteria reported include, *E. coli*, *Salmonella spp.*, *Shigella spp.*, *Bacillus cereus*, *Clostridium spp.*, *Staphylococcus aureus*, *Vibrio spp.*, *Listeria monocytogenes*, *Campylobacter spp.*, *Yersinia spp.* *Brucella spp.*, *Mycobacterium spp.* etc. Among viruses, rotavirus, norovirus (Norwalk like viruses) and hepatitis (A&E) virus etc are reported to be predominant. Foodborne diseases can be of three types:

1. **Foodborne infection** - Ingestion of viable pathogens along with food e.g. typhoid
2. **Foodborne intoxication** (poisoning) - Ingestion of foods containing preformed toxins e.g. botulism, staphylococcal poisoning
3. **Toxico-infection** - Organisms produce toxins in-situ when ingested along with food e.g. *B. cereus* poisoning



**Salmonellosis** - The salmonellae constitute a group of organisms with over 2500 different serotypes. These organisms are capable of causing disease in animals and man when taken into the body in sufficient numbers. Many salmonella species have a wide host range. These are the organisms which commonly cause food poisoning. However, some are restricted to a single host species e.g. *Salmonella Abortus ovis* causing abortion in ewes, and *Salmonella Gallinarum* the cause of fowl typhoid. Conversely, some salmonella serotypes are associated with human disease and are not known to affect animals e.g. *S. Typhi* and *Salmonella Paratyphi*. Salmonellae are ubiquitous in the gut of human and animals and act as sources of food contamination. People who are carriers of the salmonellae contaminate the food. A heavy dose up to 10,000 -1,000,000 organisms per gram of food is required to cause infection. Salmonellae grow well on food and can exist for a considerable period in feces and on pastures. Common food poisoning serotypes involved in food poisoning include *Salmonella Typhimurium*, *Salmonella Enteritidis*, *Salmonella Dublin*, *Salmonella Senftenburg*, *Salmonella Virchow*, *Salmonella Montevideo*, *Salmonella Infantis* and *Salmonella Newport*. These species are also involved in causing diarrhoea in animals (Jajere, 2019).

**Campylobacteriosis (Campylo=curved/twisted)** - Campylobacter are a group of tiny strictly micro-aerophilic, curved or spiral (corkscrew shaped), non-spore forming, Gram negative rods. Organism is Oxidase positive. Motile by either unipolar or bipolar flagella. About 12 species of Campylobacter are known (*C. jejuni*, *coli*, *lari*, *hyointenstenalis*, *upsaliensis*). *Campylobacter jejuni* and *Campylobacter coli* cause food poisoning and are associated with acute enterocolitis in man. *Campylobacter jejuni* occur in large numbers in cattle feces and poultry as normal flora, where it remains as harmless commensal. *C. jejuni* is an Emerging Foodborne Pathogen (Silva *et al.*, 2011).

**Escherichia coli** - *Escherichia coli* is a Gram-negative, facultatively anaerobic, non-spore forming rod-shaped bacterium (2.0x 0.25–1.0 µm) of the genus *Escherichia* that is commonly found in the lower intestine of warm-blooded organisms. Organisms are catalase positive and oxidase negative (Jang *et al.*, 2017). *E. coli* strains involved in food borne infection fall into the following groups:

1. Enteropathogenic *E. coli* (EPEC),
2. Enterotoxigenic *E. Coli* (ETEC),
3. Enteroinvasive *E. coli* (EIEC) and
4. Enterohemorrhagic *E. coli* (EHEC) or VTEC
5. Enterroaggregatice *E. coli* (EAggEC)
6. Diffusely adherent *E. coli* (DAEC) /Extraintestinal *E. coli* (ExPEC)



**Shigellosis (Bacillary dysentery)** - Shigellosis is caused by members of the genus *Shigella*. It is Gram -, Rod shaped, non-encapsulated, non-motile, non-spore forming, Facultative anaerobic, Facultative intracellular, Obligate pathogen. All ferment glucose, some ferments mannitol. The species involved include *Shigella dysenteriae*, *Shigella flexneri*, *Shigella boydii* and *Shigella sonnei* (Niyogi, 2005).

- ❖ Serogroup A: *S. dysenteriae* (15 serotypes)
- ❖ Serogroup B: *S. flexneri* (six serotypes)
- ❖ Serogroup C: *S. boydii* (19 serotypes)
- ❖ Serogroup D: *S. sonnei* (one serotype)

**Vibrio spp.** - Cholera is caused by *Vibrio cholerae* bacterium. *Vibrio* is a genus of Gram-negative bacteria possessing a curved rod shape (comma shape). Usually associated with eating under-cooked seafood. Typically found in salt water. *Vibrio* spp. are facultative anaerobes that test positive for oxidase and do not form spores. All members of the genus are motile and have polar flagella with sheaths.

**Yersinia enterocolitica** - This organism has been isolated from beef, lamb, pork, sea foods, vegetables milk and milk products, vacuum-packed meat. Of all the sources, swine appears to be major source of strains pathogenic to man. At present, the genus *Yersinia* includes 11 established species: *Y. pestis*, *Y. pseudotuberculosis*, *Y. enterocolitica*, *Y. frederiksenii*, *Y. intermedia*, *Y. kristensenii*, *Y. bercovieri*, *Y. mollaretii*, *Y. rohdei*, *Y. aldovae* and *Y. ruckeri*. Among them only *Y. pestis*, *Y. pseudotuberculosis* and certain strains of *Y. enterocolitica* are of pathogenic importance for humans. Virulence appears to be as a result of tissue invasiveness of this organism (Robins-Browne, 2012).

**Arcobacter** - *Arcobacter* is a genus of Gram-negative, spiral- shaped bacteria in the epsilonproteobacteria class. It shows an unusually wide range of habitats, and some species can be human and animal pathogens. Species of the genus *Arcobacter* are found in both animal and environmental sources, making it unique among the epsilonproteobacteria. This genus currently consists of five species: *A. butzleri*, *A. cryaerophilus*, *A. skirrowii*, *A. nitrofigilis* and *A. sulfidicus*, although several other potential novel species have recently been described from varying environments (Ferreira *et al.*, 2016).

**Brucellosis Species** - *B. melitensis*, *B. abortus*, *B. suis*, *B. canis*, *B. ovis*, *B. neotomae*, *B. microti*, *B. pinnipedialis*, *B. ceti* (Seleem *et al.*, 2010). **Sources of infection are** environment, persons, diseased animals. It causes malta fever, undulant fever, headache, sweating, chills, joint and muscle pain



**Pseudomonas infection** – Species involved are *Ps. putrifaciens*, *Ps. viscosa*, *Ps. fragi*, *Ps. Aeruginosa*. Sources is water, utensils, udder, teat, cowshed environment.

**Q fever** - *Coxiella burnetti* the bacterium is an obligate intracellular pathogen and can survive pasteurization and freezing temp. Incubation period between 2-4 weeks. Infection occurs through consumption of raw milk, contaminated butter and cheese. Infection may also occur through contact with infected placentas, contaminated straw beddings and animal carcasses or slaughterhouse offals (Kazar, 2005).

## Conclusion

The major causes of human illness worldwide are food-borne zoonotic bacterial infections, which have a particularly heavy impact in poorer nations and result in significant economic loss in addition to public health issues. The most prevalent bacterial infections associated to animal-derived foods include *S. aureus*, *Salmonella* species, *Campylobacter* species, *L. monocytogenes*, and *E. coli*. From the point where food animals are produced until they are consumed at the end, these microorganisms may enter the food chain. Because of the increasing number of multidrug-resistant variants, these bacterial diseases currently pose a serious threat to public health.

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