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Mini Review

Opportunistic Food Borne Infections: A Brief Review

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Abstract

While food borne infections and intoxications are frequently reported, the consequence of food poisoning caused by the normal flora remains obscure. If the immune system is compromised the normal flora could be pathogenic which in turn may result in disease outbreaks upon consumption of contaminated foods. Thus the current literature has attempted to discuss the food borne pathogenesis by the opportunistic pathogens. In this article, a mini review of literatures as well as an ingenious model was adopted to give an update on the opportunistic microorganisms involving food borne infections and intoxications. The current review delivers an understanding of the model and the pathogenesis by the opportunistic microorganisms finally resulting in food borne illness. Besides, the risk assessment of the opportunistic strains would benefit the betterment of the mass public health. The model proposed in this review is for the first time which may aid to simply understand the food borne complications caused by the normal flora.

Keywords: Food Microbiology; Opportunistic Pathogens; Pathogenesis; Normal Flora; Public Health.

Background

An array of study on food microbiology unraveled the association of food borne microorganisms including *Staphylococcus spp., Vibrio spp., Enterococcus spp., Betaproteobacteria spp. Pseudomonas spp., Stenotrophomonas spp., Acinetobacter spp., Klebsiella spp., Escherichia spp., Enterobacter, Proteus spp., Serratia spp., Aeromonas spp., Salmonella enterica, Bacteroides fragilis, Streptococcus pyogenes, Bacillus anthracis, B. cereus*; the emerging food borne pathogen *Arcobacter spp*., *Cronobacter spp*. and *Listeria spp*. Their associated pathogenesis and the subsequent modes for microbial infection, intoxication and the toxi-coinfection have been detected [1-4].

A food borne infection is known to involve the ingestion of the microbial pathogen, which in turn, continues to grow and survive within the food accompanied by tissue invasion with the concomitant release of toxins and virulent enzymes [5,6]. Another term used in food microbiology is the food borne intoxication which is generally associated with consumption of food containing the preformed toxins produced by microbial growth prior to ingestion [6-13]. Besides the cases of food borne infections and intoxication, another clinically important food spoilage phenomenon must be pondered in case immune-suppressed persons, which is the focus of the current review. In the immune-compromised patients, fresh foods, salad vegetables, water, fish, meat, poultry and raw milk food and even water may serve as the major sources severe extra intestinal infection with the symptoms of gastroenteritis accompanied by profuse watery diarrhea especially among the young children less than 5 years old, principally caused by *Aeromonas* species [6]. *Arcobacter* spp., the emerging oportunistic pathogen (especially *A. butzleri* and *A. cryaerophilus*, isolated from human diarrhoeal stool) account food borne illness among human and animals [3]. Other major pathogens involved in the food borne pathogenesis in the immune-suppressed patients have been reported to be *Brucella spp., Campylobacter spp., Bacillus cereus, Clostridium botulinum and C. perfringens; Moraxella; Corynebacterium; Listeria spp., Pseudomonas spp., Cronobacter sakazakii; Shigella dysentariae, S. flexneri, S. boydii and S. sonnei; Salmonella spp., Vibrio cholerae, Yersinia enterocolitica, Plesiomonas shigelloides, Proteus spp.*, enteroinvasive *Escherichia coli* (EIEC), enteropathogenic *E. coli* (EPEC), enterohaemorrhagic E. coli (EHEC), Verotoxin-producing *E. coli* (VTEC), etc. [5-7,14-16].

Rationale of current review

Food borne diseases or food poisoning are generally categorized into the food borne infections, intoxications, and toxi-coinfections [17]. An interesting study indicating cyaniding as the potential Quorum Sensing (QS) based anti-biofilm and anti-bacterial agent for food borne pathogens would be strategically a proof of the involvement of QS mechanisms in case of shading the food borne infections [18]. Another important food borne infection strategy can be mediated by the cultivable, and highly competitive opportunistic pathogens which are often found to be associated with other eukaryotic hosts such as plants [19,20]. These are highly versatile in nutrition requirements; resistant against antibiotics and toxins; and they have the unique capacity of biofilm formation. Now a days, an increased number of immunocompromised individuals resulted in a superior number of food borne disease outbreaks associated with the consumption of vegetables [19]. Therefore, in order to understand the human health risk caused by food borne microorganisms which are opportunistic in nature, the current literature review has been made in a brief form so that the food microbiologists can be aware of the virulence potential opportunistic microbial species which are apparently known to be beneficial for human health.

Prevalence of opportunistic pathogens in plants and food borne diseases

The endospheres and rhizospheres of plants have been reported as the significant reservoirs for emerging opportunistic pathogens like *Escherichia coli* pathotypes, *Burkholderia, Enterobacter, Pseudomonas, Ralstonia, Serratia, Staphylococcus, Stenotrophomonas*, the multi-drug resistant multi-resistant species of *Pseudomonas* and *Stenotrophomonas*, resulting in disease outbreaks [20-22]. Ironically it is to be noted that if plants serve as a natural reservoir of *Enterobacteriaceae*, then these bacteria apparently may seem to be natural part of human diet. Among the vegetable microbiomes, the opportunistic pathogens have a broad phylogenetic background frequently conquer the natural environments or associated with eukaryotic hosts maintaing an endophytic lifestyle which is quite beneficial for the immunocompetent hosts; whereas in the immunocompromised individuals, opportunistic pathogens can cause severe infections like pneumonia, bloodstream infections, urinary tract infections, surgical site infections and also diarrhea (Berg *et al*., 2014). A recent study using the whole genome sequencing (WGS) unraveled a connection between *Cronobacter sakazakii* (a member of the family Enterobacteriaceae) and food-borne acute gastroenteritis (AGE) among the neonates, infants, and adults with immunocompromised condition *Cronobacter* spp. [5]. However, the pathogenicity and epidemiology of this species has not been well described till date. An interesting area of study of opportunistic microorganisms lies on the probiotics. The *Lactobacillus* genus complex (LGC), which is usually the resident within the fermented food products (or supplied as supplement), is known to normally colonize the mouth, gastrointestinal (GI) tract, and female genitourinary tract of humans because of their multiple beneficial effects. Surprisingly food borne infections like endocarditis, bacteremia, and pleuropneumonia by lactobacilli; i.e., *Lactobacillus rhamnosus* have recently been reported [23].

Besides bacteria, food borne opportunistic bacterial species, an emerging fungal species which can act as a threatening to human health is the opportunistic pathogenic version of the yeast *Saccharomyces cerevisiae*, which is most commonly known as "baker's yeast" in either traditional or industrial fermentative production of bread, beer or wine. Interestingly they are adapted to resist human defenses; i.e., to the reactive oxygen and nitrogen species [24].

Pathogenesis during opportunistic infections

The possible virulence factors for the opportunistic infections were previously analyzed and the O antigen gene cluster (OGC) has been reported to be responsible one for the opportunistic food borne infection especially by the species of *Salmonella spp., Escherichia coli,* and *Shigella* [15,25]. Bacterial polysaccharides such as capsular polysaccharides (K antigens) and O polysaccharides (O antigens, responsible for adhesion, cell recognition, and biofilm formation), present on the bacterial cell surfaces may serve as the mediator for the host - pathogen interactions [26-28]. Along with the discovery of the novel protein Wzz (that regulates the chain length of the O antigen and that is essential for the pathogenesis), the genetic studies for the O antigen synthesis revealed the nucleotide sugar synthesis genes; genes encoding glycosyltransferases (GTs), genes encoding the flippase and the polymerases [15,25]. Considering these suggestive data, a general model of the opportunistic food borne infections has been proposed (Figure 1).

Mechanism of opportunistic food borne infection

It is known that the opportunistic pathogenic microorganisms usually do not shed disease in the healthy, immunocompetent host; rather these microorganisms are likely to take benefit from the compromised immune system of hosts, caused by recurrent infections, genetic predisposition, and due to several long-term antibiotic treatments; application of the immunosuppressive agents for organ transplant recipients; and the chemotherapy for cancer [19].

Cronobacter spp., including *C. sakazakii, C. malonaticus, C. muytjensii, C. turicensis, C. dublinensis, C. universalis and C. condiment*, causing diarrhea, meningitis, enterocolitis, bacteraemia or sepsis, can be a role model for understanding the opportunisctic food borne infections. The genetic makeup of *Cronobacter* virulence principally underlies on the cpa gene, encoding the plasminogen activator, fhaBC gene, encoding the filamentous haemagglutinin gene; and the *repA* gene, encoding the general replication protein. Some other important opportunistic infection aspects cover (1) the potential of biofilm formation; (2) production of the outer-membrane protein A; and (3) the escaping strategy of the immune response by using the immature dendrites and macrophages [4].

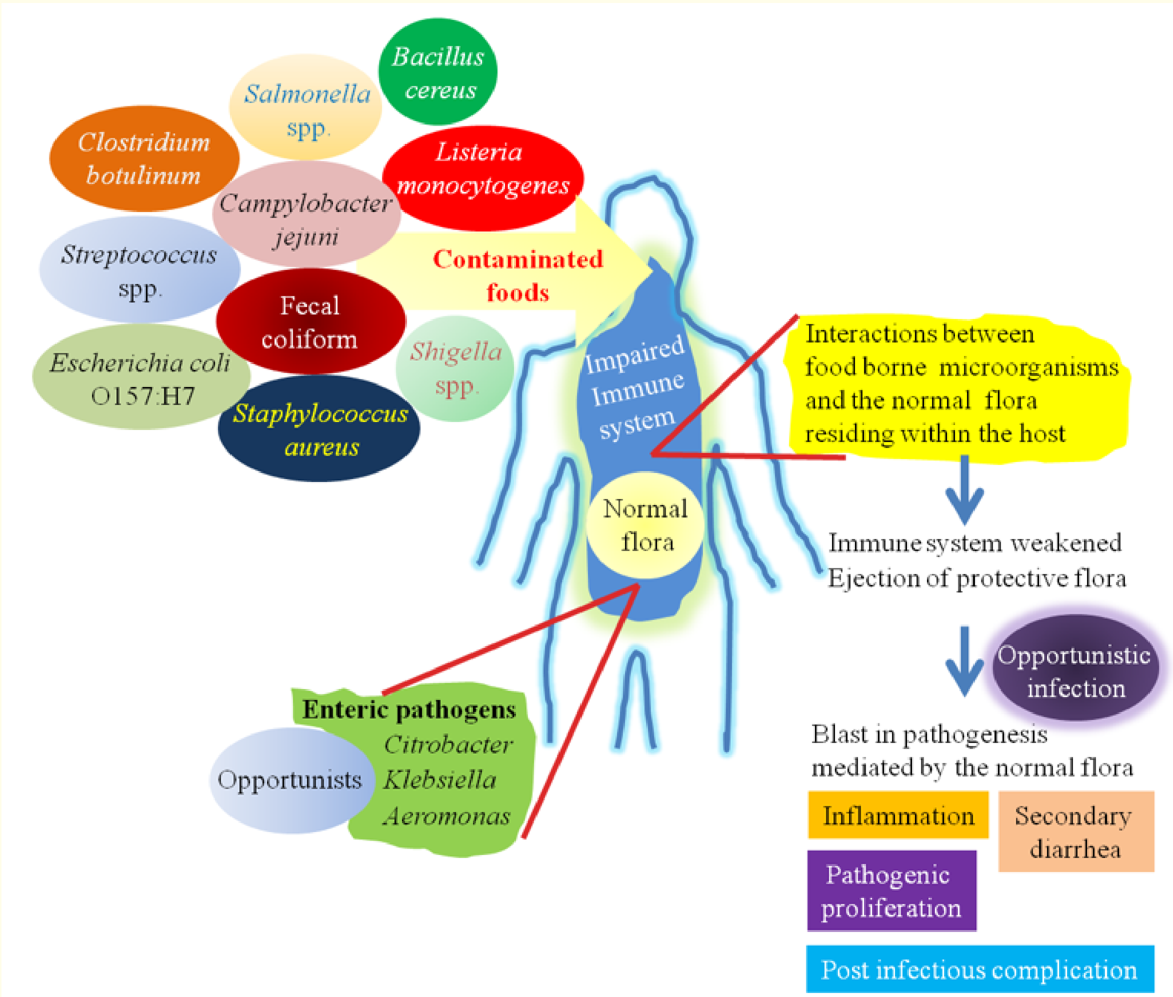

Figure 1: General model of opportunistic food borne infection and pathogenesis. Ingestion of microbial pathogens through the contaminated foods may combat the normal flora residing the host which in turn, may become invasive, resulting in food borne infections. On the other hand, the gastrointestinal flora may sometimes become pathogenic when the host's immune system is compromised. Therefore, the weakened immune system may trigger the normal flora to transform into food borne pathogens.

Food borne opportunistic infections and public health assessment

For the detection of food borne pathogens, traditional and simple culture methods undoubtedly urge a very practical means in the area of public health maintenance; nevertheless, such detection techniques are certainly laborious and time dependent. However, while an array of traditional methods of detecting food borne diseases are being applied [8,9,29-31], the quantitative microbial risk assessment (QMRA), built on experimental and meta-analytical data, stands as a comparatively new-fangled advancement in identifying health risks allied with the ubiquitous presence of opportunistic pathogens in the human environment [32]. The method is also suitable for the detection of the opportunist waterborne infections (OWI), principally the *Legionella* spp. [32,33]. It is to be pondered that the molecular methods involving the identification of virulent genes are also significant in the detection of food borne infections which may be opportunistic [26,34,35].

Conclusion

The interplay between the infectious microorganisms and/or the normal flora and the immunocompromised host is always of great clinical interest for the scientist since a long time. Current review revealed the state of pathogenecity of the opportunistic microorganisms upon food ingestion especially in case of the immunocompromised persons. The proposed model of opportunistic food borne pathogenic infection may aid new insight to the current knowledge in food microbiology. Increased information on the function of the food borne microorganisms as an immune-stimulant may be expected to trigger to develop vaccines against the food borne diseases. Besides, in course of maintenance of sound public health, the knowledge from this very literature may be propagated publicly to increase the awareness on food borne complications.

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Conflict of Interest

Authors have no potential conflict of interests.

Bibliography

1. Elmahdi S., *et al.* "Vibrio parahaemolyticus and Vibrio vulnificus Recovered from Oysters during an Oyster Relay Study". *Applied and Environmental Microbiology* 84.3 (2018).

2. Ramees TP., *et al.* "Arcobacter: an emerging food-borne zoonotic pathogen, its public health concerns and advances in diagnosis and control - a comprehensive review". *The Veterinary quarterly* 37.1 (2017): 136-161.

3. Adesiji Y O., *et al*. "Arcobacter, an emerging opportunistic food borne pathogen-A review". *African Journal of Medicine and Medical Sciences* 43 (2014): 5-11.

4. Jaradat ZW., *et al*. "Cronobacter spp.-opportunistic food-borne pathogens. A review of their virulence and environmental-adaptive traits". *Journal of Medical Microbiology* 63.8 (2014): 1023-1037.

5. Yong W., *et al.* "An Investigation of an Acute Gastroenteritis Outbreak: Cronobacter sakazakii, a Potential Cause of Food-Borne Illness". *Front Microbiology* 9 (2018): 2549.

6. Bezirtzoglou E., *et al.* "Food-Borne Intestinal Bacterial Pathogens". *Microbial Ecology in Health and Disease* 12.2 (2000): 96-104.

7. Noor R and Feroz F. "Food safety in Bangladesh: A microbiological perspective". *Stamford Journal of Microbiology* 6.1 (2017): 1-6.

8. Noor R and Feroz F. "Requirements for microbiological quality management of the agricultural products: an introductory review in Bangladesh perspectives". *Nutrition & Food Science* 45.5 (2015): 808-816.

9. Noor R. "Microbiological quality of commonly consumed street foods in Bangladesh". *Nutrition & Food Science* 46.1 (2016): 130-141.

10. Noor R., *et al.* "Assessment of Survival of Pathogenic Bacteria in Raw Fresh Vegetables through in vitro Challenge Test". *International Journal of Food Contamination* 2 (2015): 15.

11. Noor R., *et al.* "Demonstration of virulent genes within Listeria and Klebsiella isolates contaminating the export quality frozen shrimps". *International Aquatic Research* 7.2 (2015): 157-161.

12. Noor R., *et al.* "Molecular characterization of the virulent microorganisms along with their drug-resistance traits associated with the export quality frozen shrimps in Bangladesh". *Springer Plus* 3 (2014): 469.

13. Alam MS., *et al.* "Microbiological contamination sources of freshly cultivated vegetables". *Nutrition & Food Science* 45.4 (2015): 646-658.

14. Gnanasekaran G., *et al*. "The complete genome sequence and comparative genome analysis of the multi-drug resistant food-borne pathogen Bacillus cereus". *Genomics* (2019).

15. Cao H., *et al.* "Identifying genetic diversity of O antigens in Aeromonas hydrophila for molecular serotype detection". *PLoS One* 13.9 (2018): e0203445.

16. Walke S., *et al.* "Opportunistic Pathogens in the Mucous of Skin, Gills, Fins and Mouth of Labeo Rohita". *International Journal of Fisheries and Aquatic Studies* 3.1 (2015): 169-172.

17. Scannell A G M. "Overview of foodborne pathogens". In D. W. Sun (Eds.), Handbook of Food Safety Engineering. Oxford, UK: Wiley-Blackwell (2011).

18. Gopu V and Shetty PH. "Cyanidin inhibits quorum signalling pathway of a food borne opportunistic pathogen". *Journal of Food Science and Technology* 53.2 (2016): 968-976.

19. Berg G., *et al*. "Vegetable microbiomes: is there a connection among opportunistic infections, human health and our 'gut feeling'?". *Microbial Biotechnology* 7.6 (2014): 487-495.

20. Leff JW and Fierer N. "Bacterial communities associated with the surfaces of fresh fruits and vegetables". *PLoS One* 8.3 (2013): e59310.

21. Rahman H., *et al.* "Demonstration of the source of microbial contamination of freshly cultivated cabbage, cauliflower, potato and squash collected from rural farms of Bangladesh". *International Food Research Journal* 23.3 (2016): 1289-1295.

22. Mendes R., *et al*. "The rhizosphere microbiome: significance of plant beneficial, plant pathogenic, and human pathogenic microorganisms". *FEMS Microbiology Reviews* 37.5 (2013): 634-663.

23. Rossi F., *et al.* "Members of the Lactobacillus Genus Complex (LGC) as Opportunistic Pathogens: A Review". *Microorganisms* 7.5 (2019): 126.

24. Pérez-Torrado R and Querol A. "Opportunistic Strains of Saccharomyces cerevisiae: A Potential Risk Sold in Food Products". *Frontiers in Microbiology* 6 (2016): 1522.

25. Woodward R., *et al*. "In vitro bacterial polysaccharide biosynthesis: defining the functions of Wzy and Wzz". *Nature Chemical Biology* 6.6 (2010): 418-23.

26. Liu C., *et al.* "Rapid and Simple Detection of Viable Foodborne Pathogen Staphylococcus aureus". *Frontiers in Chemistry* 7 (2019): 124.

27. Liu B., *et al.* "Structural diversity in Salmonella O antigens and its genetic basis". *FEMS Microbiology Reviews* 38.1 (2014): 56-89.

28. Raetz CR and Whitfield C. "Lipopolysaccharide endotoxins". *Annual Review of Biochemistry* 71 (2002): 635-700.

29. Akond MA., *et al.* "Isolation of a potential antifungal Bacillus subtilis 37-JM07 strain from straw and its biocontrol efficacy to combat green mold disease of commercial mushroom, Pleurotus ostreatus". *Environmental Science: An Indian Journal* 12.1 (2016): 001-014.

30. Mahfuza I., *et al.* "Microbial status of street vended fresh-cut fruits, salad vegetables and juices in Dhaka city of Bangladesh". *International Food Research Journal* 23.5 (2016): 2258-2264.

31. Rahman F and Noor R. "Prevalence of pathogenic bacteria in common salad vegetables of Dhaka Metropolis". *Bangladesh Journal of Botany* 41.2 (2012): 159-162.

32. Bentham R and Whiley H. "Quantitative Microbial Risk Assessment and Opportunist Waterborne Infections¯Are There Too Many Gaps to Fill?". *International Journal of Environmental Research and Public Health* 15.6 (2018): 1150.

33. Petterson SR and Ashbolt NJ. "QMRA and water safety management: review of application in drinking water systems". *Journal of Water and Health* 14.4 (2016): 571-589.

34. Rajabzadeh S., *et al*. "A rapid method for separating and concentration of food-borne pathogens using elution from ready-to-eat vegetables". *Iranian Journal of Microbiology* 10.6 (2018): 385-393.

35. Sarker N., *et al.* "Use of multiplex PCR assay for detection of diarrheagenic Escherichia coli in street vended food items". *American Journal of Life Sciences* 1.6 (2013): 267-272.

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