Food microbiology

Sayan Bhattacharyya

Associate Professor, Department of Microbiology, AIIH and PH, Kolkata, West Bengal

ABSTRACT

Background: Food is imperative for continuation of life. However, it is also an important vehicle of entry of infections. Bacterial, viral and parasitic agents, causing these infections can all spread by food. Bacteria can produce many toxins and also be invasive sometimes, which can lead to diarrhoea and dysentery, respectively. This contamination takes place by risks like cooking food at improper temperature and keeping food open after cooking. These risks lead to various hazards. Also, microbes can help prepare different foods like fermented foods and kombucha tea. Modern society relies heavily on processed and ready-to eat foods, both of which can cause foodborne infections. Keeping all these things in mind, the science of food microbiology becomes very important in modern times. **Aim:** All these aspects of food microbiology and food safety have been discussed in this chapter. **Objectives:** Many points like food safety, cleanliness and other aspects like chilling of cooked food minimize risks of microbial food contamination and resultant hazards, have been elaborated upon. **Methods:** Scientific literature search was carried out to study the risk factors and related reports with respect to food microbiology, by food scientists and others. **Results:** Food contamination can be of microbial origin and a multitude of factors may lead to microbial contamination of food. These factors could be improper cooking, leaving cooked food uncovered, and other things. **Conclusion:** Food microbiology is a very important aspect of public health and quite neglected too. It should be given its due importance to mitigate microbial contamination of food and consequent foodborne infections.

Key words: *Food, Hazard, Safety, Probiotics, Toxins*

Food science is an ancient topic and is emerging also as a popular subject. Food microbiology covers two aspects: (a) Microbes used in preparing and preserving food, and (b) microbes and their toxins which can spread by food. Hence, consuming microbiologically safe food is as important as having nutritious food. Food borne infections and intoxications are on the rise, due to more urbanization and increased number of unregistered eateries. Hence, nowadays, food microbiology is considered as an important component of public health, especially public health microbiology.

Many microbes can be used to prepare food. Yeast extract obtained from *Saccharomyces cerevisiae* is helpful in preparing food items such as idli, bread, soya sauce, and others. Yeasts help in the fermentation process and, thereby, can generate carbon dioxide from sugars. This air generated, makes the food items such as bread and dli fluffy.

Probiotics, on the other hand, are live microorganisms, which when ingested in small amounts, impart many health benefits to the host. Most commonly used probiotics are bacteria such as *Lactobacillus* spp. and *Lactococcus* spp., and yeasts like *S. cerevisiae* var. *boulardii*. Prebiotics, on the contrary, are dietary elements such as fructoologosaccharides and galactooligosaccharides, which help increase numbers of probiotic micro-organisms in the gut. Chicory, oats, inulin, and garlic are known to be good prebiotics. On the other hand, synbiotics are mixtures of prebiotic and probiotic.

Fungi themselves may also be useful as food. For example, mushrooms can be used as food and are rich in proteins and fiber, simultaneously being low in calories. Kombucha tea is an aqueous extract from fungi. It is a rich source of antioxidants, vitamins, and minerals. Yeasts also help in fermentation and resultant production of wine and other fermented drinks.

Fungal toxins are also found in food grains, such as aflatoxin in maize and other grains. Aflatoxin is an important causative factor behind hepatitis and hepatocellular Carcinoma. Other mycotoxins are also important, such as ricin, patulin, and ergot alkaloids.

Apart from these, prions can also be transmitted by food, by eating practices such as having beef and practices such as ritualistic cannibalism.

Access this article online

Received - 15 January 2024
Initial Review -02 February 2024
Accepted - 06 February 2024

DOI: 10.32677/ejms.v8i3.4433

Quick Response code

Correspondence to: Sayan Bhattacharyya, Department of Microbiology, AIIH and PH, Kolkata, West Bengal. E-mail: sayantheboss@yahoo.co.in

Examples of Bacterial Foodborne Infections

Bacteria are notorious for causing foodborne infections, important among which are food poisoning due to *Bacillus cereus*, *Staphylococcus aureus,* and other bacteria. Different types of food matter harbor different bacteria, such as *S. aureus* in dry sweets, *B. cereus* in rice and noodles, and others. The expression of different toxins in food depends on the composition of the food matter. *B. cereus* in rice expresses cereulide toxin, which induces nausea and vomiting, while the same bacterium present in chicken meat expresses cytotoxin and non-hemolytic enterotoxin, which produces diarrhea and dysentery.

Bacterial Food Poisoning According to Type of Food

A. Sweets and cream:- Nausea and vomiting due to *S. aureus* poisoning. Enterotoxin A to E is responsible. *S. aureus* comes to the food through infected hands and people also harbor these bacteria in their external nares.
B. Seafood:- Diarrhea and dysentery due to *Vibrio parahaemolyticus* may spread from seafood. This is a halophilic *Vibrio* species.
C. Contaminated potable water:- Watery diarrhea due to *Vibrio cholerae* is reported here. This bacterium is present in water having salinity 3–6%. Hence, it is a halophilic *Vibrio* spp.
D. Chicken:- *Clostridium perfringens* food poisoning can occur. This occurs after eating contaminated meat or poultry. Stomach cramps and diarrhea can occur, but no vomiting.
E. Fish:- Improperly cooked fish, especially beckti fish, may transmit parasitic infections such as *Diphyllobothrium latum* infections.
F. Salads (such as potato, shrimp, turkey, tuna, chicken, fruit, macaroni, and lettuce), and other foods such as chopped turkey, rice balls, pudding, beans, strawberries, raw oyster, spinach, luncheon meat, and milk are responsible for spread of *Shigella* spp.

Viral Food Poisoning According to Type of Food

A. Rotavirus:- Water is responsible mostly. Mostly rotavirus diarrhea occurs in children <5 years of age.
B. Hepatitis A and E virus:- Contaminated drinking water is the portal of entry.
C. Norovirus:- Contaminated food and water are responsible.
D. Adenovirus 40 and 41 can spread by food. These infections spread by having contaminated food and water and are reported mostly in children.

Parasitic Agents Causing Foodborne Infections

Protozoa such as *Entamoeba histolytica* and *Giardia lamblia* may spread through food. Furthermore, helminth eggs such as

Figure 1: Street food in Kolkata (Sujir bhapa pithe)

Figure 2: Street food, esp. seafish, can lead to many foodborne infections

Ascaris lumbricoides and *Trichuris trichiura* may spread through contaminated food. Habits like chewing of nails may help spread of eggs of *Enterobius vermicularis*.

Diagnosis of Bacterial Foodborne Infections

Samples such as food matter and rectal swab or stool are ideal for diagnosis of foodborne infections. Microscopy and culture should yield the diagnosis. Culture on blood agar containing human blood group O (Wagatsuma agar) shows hemolysis when *V. parahemolyticus* colonies appear [1]. Representative pictures of street food are shown in Figures 1 and 2 which show street food and seafood, respectively.

Factors present in Food that Lead to Microbial Contamination

A. Keeping foods like rice uncovered for a long time after cooking: - This leads to contamination of food by *B. cereus*; these bacteria come from the ambient air above.
B. Water activity (aW) of food:- Dry foods have lesser chance of getting contaminated. Moist or watery foods such as milk, meat, and cottage cheese are more likely to get contaminated

by microbes. Humidity of ambient air and moisture content are also important for microbial contamination of food.

C. Not cleaning food properly:- Unclean food is likely to get contaminated by microbes more often.
D. Porous or air-containing food:- Air-containing food is obviously more prone to microbial contamination since most microbes need Oxygen (aerobic ones). Minced meat is more contaminated with pathogens as compared to whole uncut meat due to more air availability.
E. Sometimes prolonged refrigeration leads to cold enrichment, or more growth of bacteria such as *Listeria* spp. and *Yersinia enterocolitica*.
F. Mixing animal or bird meat with gut contents:- Such mixing makes meat prone to contamination by bacteria such as *Campylobacter jejuni* and protozoa such as *Balantidium coli* (in case of pork). Bacteria such as *Campylobacter* spp. and *Salmonella* spp. can also come from the equipment used [2].
G. Mixing of meat with neural tissue components:- Such mixing may lead to prion diseases, like variant CJD. The risk is more with beef.
H. Having canned soft drinks:- This is a risk factor for foodborne Leptospirosis. This is because the outer can surface may contain rat urine, and when can opens inwards then the bacteria may gain entry into the food product.

Keeping food uncovered for a long time after cooking, and storing food in dirty containers, are examples of "risks." Such risks lead to hazards, like contamination of food by *B. cereus*. Risks can be controlled by altering 'critical control points' such as temperature, cooking time, moisture content, and others study of these risks, hazards, and critical control points are called HACCP or Hazard Analysis and Critical Control points.

How to Reduce Microbial Contamination of Food

A. Covering cooked food:- This prevents starchy food like rice getting contaminated by aerial spores of *B. cereus*, which is also aided by refrigeration after cooling of cooked rice [3].
B. Immediate refrigeration after cooking and cooling is also helpful. Furthermore, food, especially fruits, should be cleaned and non-vegetarian items separated from vegetarian items. This goes by the sequence:- Clean, separate, cook, and chill [4]. Refrigeration prevents microbial multiplication. Proper social handwash is also important as regards food safety.
C. Using some preservatives like high amount of salt (brine), especially for maize/corn. This disallows microbial multiplication.
D. Pasteurization of milk and milk products. This process kills many bacteria but not *C. burnetti* and also cannot kill *Brucella abortus* sufficiently. It can also favor presence of enterotoxin-producing *S. aureus*. Pasteurization usually provides a 5 – log reduction of bacteria [5]. UHTST method of pasteurization also kills the spoilage-causing microorganisms.
E. Water can be filtered and subjected to UV radiation. It can also be disinfected using Chlorination [6].
F. Powdered spices can be subjected to sterilization by gamma radiation or by hot steam or hot water vapor [7].
G. Street eateries should have proper license and food prepared that there should be monitored regularly for microbiological quality. They should also undergo health education [8].

DISCUSSION

Food microbiology is a very important branch and component of public health. Many factors like improper cooking and insufficient social hand washing can be held responsible behind microbial contamination of food [9]. Aerobic bacteria like Escherichia coli and Vibrio cholerae, as also anaerobes like Clostridium perfringens can be potentially harmful when ingested. Not only microbes, but their toxins can also contaminate food. These hazards and risks are very important to know and remember. Also, probiotics are some specific living microbes like lactic acid bacteria and probiotic yeasts, which provide health benefits via foods, when ingested in small amounts. So, whilst food is so very important for sustaining life, foodborne infections can be deadly also. Many microorganisms like bacteria, protozoa and viruses can spread via food and water and cause toxic or invasive diarrhoea. Microbes can be harmful when ingested, and at the same time form components of healthy microbiome, especially in gut when ingested as probiotics. Poultry based foods are also capable of transmitting drug resistant genes, due to overuse of antibiotics as growth promoters in feeds. Microbes in food can spread via pests and mechanical vectors, and can lead to substantial morbidity and mortality, more in developing countries but also globally [10,11]. Food safety is hence very crucial and can be ensured by various methods like boiling, pasteurization and other measures like cleaning, separation and chilling of cooked food, if not consumed in time. This subject hence demands more research and scientific attention

CONCLUSION

Food microbiology is a neglected area of public health. Street food and processed food both can be dangerous when consumed. It should get its due as an area of focus in order to reduce the burden of foodborne infections and resultant morbidity and mortality, globally.

REFERENCES

1. Rouger A, Tresse O, Zagorec M. Bacterial contaminants of poultry meat: Sources, species, and dynamics. Microorganisms 2017;5:50.
2. Okuda J, Nishibuchi M. Manifestation of the Kanagawa phenomenon, the virulence-associated phenotype, of *Vibrio parahaemolyticus* depends on a particular single base change in the promoter of the thermostable direct haemolysin gene. Mol Microbiol 1998;30:499-511.
3. Rice: How to Handle it Safely. Available from: https://www.torbay.gov.uk/foodsafety [Last accessed on 2024 Jan 30].
4. Four Steps to Food Safety. https://www.cdc.gov/foodsafety/keep-food-safe.

html#:~:text=four%20steps%20to%20food%20safety%3a%20clean%2c%20separate%2c%20cook%2c%20chill&text=following%20four%20simple%20steps%20at,loved%20ones%20from%20food%20poisoning [Last accessed on 2024 Jan 14].
5. Pasteurization. Available from: https://www.sciencedirect.com/topics/nursing-and-health-professions/pasteurization#:~:text=With%20pasteurization%2C%20not%20only%20are,conditions%20should%20be%20as%20follows%3A&text=Not%20less%20than%2062.8%20%C2%B0,least%2030%20min%20(holder%20method)&text=Not%20less%20than%2071.7%20%C2%B0,at%20least%2015%20s%20(HTST) [Last accessed on 2024 Jan 13].
6. National Research Council (US) Safe Drinking Water Committee. II, The Disinfection of Drinking Water. In: Drinking Water and Health: Volume 2. Washington, DC: National Academies Press US; 1980. Available from: https://www.ncbi.nlm.nih.gov/books/NBK234590/ [Last accessed on 2023 Jan 31].
7. Sterilization of Spices, Tea, Cocoa, Curry Mixtures and Cereal Derivatives in the Amixon® Vacuum Dryer. Available from: https://www.amixon.com/en/blog/sterilisation-of-spices-tea-cocoa-grain-derivatives#:~:text=Sterile%20steam%20is%20injected%20into,are%20mixed%20gently%20and%20slowly [Last accessed on 2024 Jan 13].
8. Eromo T, Tassew H, Daka D, *et al*. Bacteriological quality of street foods and antimicrobial resistance of isolates in Hawassa, Ethiopia. Ethiop J Health Sci 2016;26:533-42.
9. Ahmednur M, Esmael M, Feresa F. Handwashing Practice of food establishment customers, microbial quality of handwashing water, and associated factors in Ginjo Kebele, Jimma Town, Southwest Ethiopia. Environ Health Insights 2022;16:11786302221144197.
10. Pest Management. Available from: https://cabellhealth.org/wp-content/uploads/2019/12/pest-management.pdf [Last accessed on 2024 Jan 30].
11. Bintsis T. Foodborne pathogens. AIMS Microbiol 2017;3:529-63.

Funding: Nil; Conflicts of Interest: None Stated.

How to cite this article: Bhattacharyya S. Food Microbiology. Eastern J Med Sci. 2023;8(3):55-58.